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Some American Work—A Green Sand Casting.

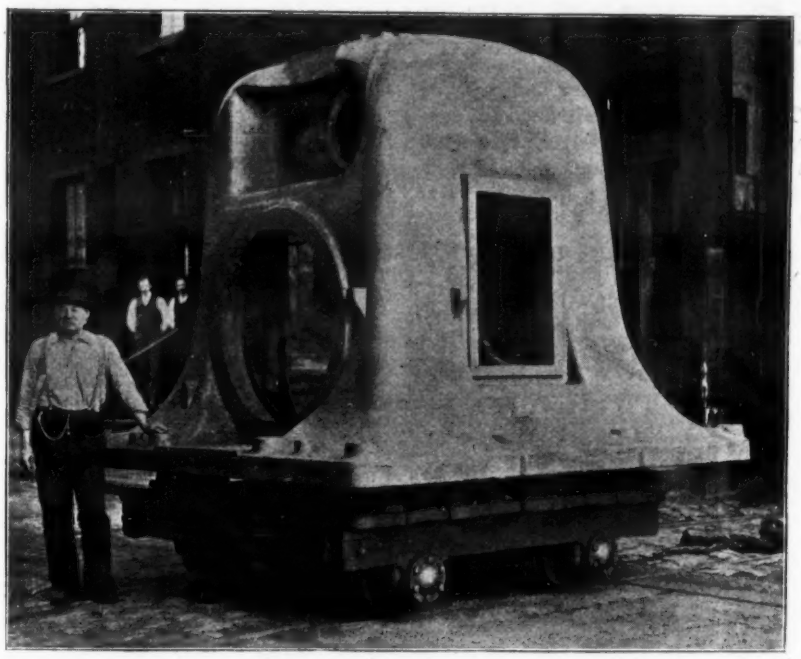
BY HARRIS TABOR.

When Professor Sweet introduced the subject of European designs, machine construction and castings, in his letters to the AMERICAN MACHINIST, he adhered to his old-time custom of stirring us up a bit, and giving us something new to think of. He aroused the spirit of jingoism in a few cases, but, in the main, his admiration for what the people on the other side do well has proved an excellent tonic for the progressive element on this side of the Atlantic. Our belief that we do all things better is the result of a vigorous self-reliance which may prove dangerous if allowed to go too far. An occasional suggestion from so good an authority, that mechanical design and construction do not belong to us exclusively, tends to set us thinking.

The European exhibits in the way of steel and iron castings at the Columbian Exposition, to which Professor Sweet referred, were certainly marvels of the molder's art, and were all he claimed for them. But were they commercial castings? Did they represent the every-day product of the foundry, or were they show pieces made only for exhibition and without regard for cost? The real test of quality is the purely commercial one, and is determined by cost and selling price. Where labor is expensive the cost limit is soon reached. The fact that such castings may be made counts for nothing; the question is, can they be produced economically for the trade; can American or other engine builders afford to make such castings for standard work, as the Le Creusot people exhibited? If the Schneiders exhibited the regular product of their foundry, we must all take off the hat to them.

The Schichau engines were by far the best finished engines at the Exposition. We had nothing that would compare with them in workmanship. The question of cost seemed not to have entered into their construction. As in the case of the fine castings, these engines were declared finished only when additional labor and cost could add nothing to their attention-drawing qualities. Such engines could not be sold on our markets at a price that would return first cost to the builder. It is probable that these engines represented much better finish than the standard German production. If they did not, we must admit that the European buyer is much less sensitive to cost than we are.

The nominal power of the larger Schichau engine was about the same as the Westinghouse verticals; its rotative speed, with only partial load, was about one-half the speed of the Westinghouse engines, yet the latter machines were quite as noiseless in motion and as reliable in action as the more brilliantly finished product of the German builder. The Schichau engine usually ran under control of the throttle for want of load, while its plainer looking neighbors often did from ten to fifteen per cent. more work than their commercial rating. In point of finish these engines would not compare, but judged by excellence, that test of successful manufacture, the Westinghouse engines were not inferior.



A GREEN SAND CASTING.

The standpoint from which we judge European machine construction is not a fair one. Our opinions, at least in a majority of cases, are formed from a study of exhibition machines which are much superior to standard commercial work. Then it is a question if any of us understand how well machine work is done in this country, or how well it might be done if we could find customers willing to pay for it. The recent additions to our Navy, and the engines in the "St. Louis," indicate that in marine construction we compare favorably with our transatlantic brothers, and economy tests in factories and water-works plants show that we have little to fear when merit settles the question.

If one will canvass this country as carefully as an American does Europe, in search of good foundry practice, the chances are his conclusions would be decidedly flattering to our pride. He will probably find that in loam work our higher price for labor prohibits the final touches of finish which characterize similar castings made in Europe, but this discrimination against us ends with superficial finish. In strength, adaptability and general excellence, our loam and dry sand castings are fully the equal of the best foreign production. If the investigator will give his attention to our green sand foundries he will catch us in our best light. In this line of metal founding we probably have no equal in the world. Our practice has brought this cheaper method of molding to such perfection that castings which would be considered difficult in loam are every day made in green sand, with results which would seem incredible to an English or German molder. These castings have the appearance of loam work; they are free from strains, truer to shape, and are produced at much less cost than dry sand or loam castings. We have drifted into this class of molding for heavy work so quietly that we do not seem to realize that it is at all remarkable. We accept it as an every-day affair, and give our praise to the Englishman or German who will produce a similar casting in loam, at double the cost. The fact that the loam molder works without pattern gives an artistic color to his method, but it does not follow that he is more of an artist than Mr. Garrett, foundry superintendent of the Westinghouse Machine Co., who made the casting herewith illustrated, in green sand.

This cut does not give Mr. Garrett the full measure of credit. A poorly molded casting would show quite as well when reduced to so small a scale. But a thorough inspection of the casting tells the story. Notwithstanding a hydrostatic pressure of 25 pounds per square inch on the lower portions of the mold, there is the same freedom from strains and irregularities that one would expect in the best loam castings. The general surface is remarkable for smoothness, and there are no fins or traces of flask joint. It would be considered an unusually fine casting from the dry sand or loam standpoint. It is so much in advance of what the majority of us expect from the green sand foundry, that I induced Mr. Bole, superintendent of the Westinghouse Machine Co., to give me the photograph from which the cut was made, for publication.

Dry sand cores were used for the foundation bolt holes. The balance of the mold was made in green sand. Mr. Garrett, who stands by the casting, is a man much above the average size. If the reader will reckon him about six feet high, and use him for a measuring stick, he will get a fair idea of the size of the casting. It is 9 feet square at the base, 7 feet 6 inches high, and weighs, after cleaning, 24,450 pounds. It has not been touched by paint or filler, but is just as the sand was peeled off from it.

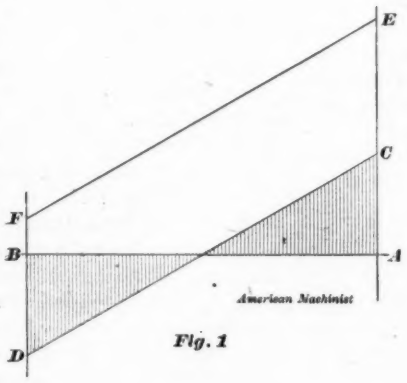


Fig. 1

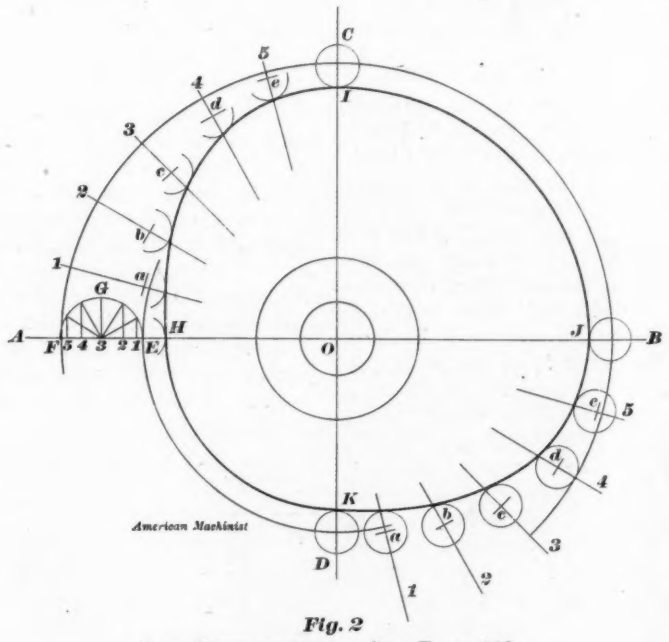


Fig. 2

CAM CONSTRUCTION.—SEE PAGE 562.

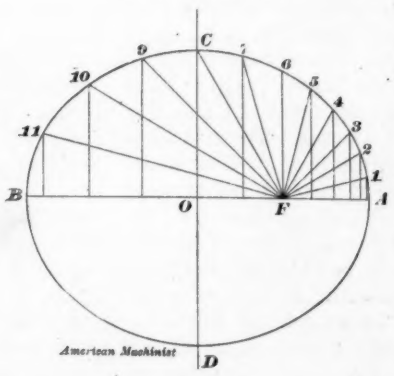


Fig. 3

A rolling stone, left inside a schooner when she was built, was recently found to have worn a groove nearly through the planking. Its timely discovery probably saved a vessel and crew.

Cam Construction.

BY C. L. REDFIELD.

Every person who has a limited knowledge of mechanical principles, but who happens to have made a fairly successful cam, knows all about cam movements, while those who have had a more extended experience always approach the subject with fear and trembling. Another peculiarity of humanity is that whenever a person learns something new, he is never satisfied until he has aired that knowledge. It matters not to which one of these first-mentioned classes I belong personally, but the fact that I have recently been studying the operations of cams under peculiar circumstances, puts me in the class of persons whose knowledge (or lack of it) burns into the brain like money in the pocket of a spendthrift, and I will therefore give the readers of the AMERICAN MACHINIST the benefit of what I have been doing.

In every case where the movement is not of a predetermined quality that of itself absolutely fixes the cam shape, the distinct object of the designer should be to make the cam movement as easy as possible. By making the cam movement "easy," I mean that the quality of the movement should be such that the strains shall not be excessive at any one particular point, and that strains in opposite directions shall merge into each other by imperceptible degrees.

In looking for some movement that would act as a guide to indicate the proper quality for a cam movement, I could find none so absolutely smooth and easy as the swing of a pendulum. When analyzed, the swing of a pendulum is bound to correspond to the movement of a cross-head driven by a crank and connecting rod of infinite length. It will, therefore, be a fair assumption to say that a cam rise in crank time would be an ideal cam movement. This would perhaps be true if all of the conditions were the same, but the swing of a pendulum is practically frictionless, while the body moved by a cam is often subject to great friction, or resistance to movement that counts the same as friction.

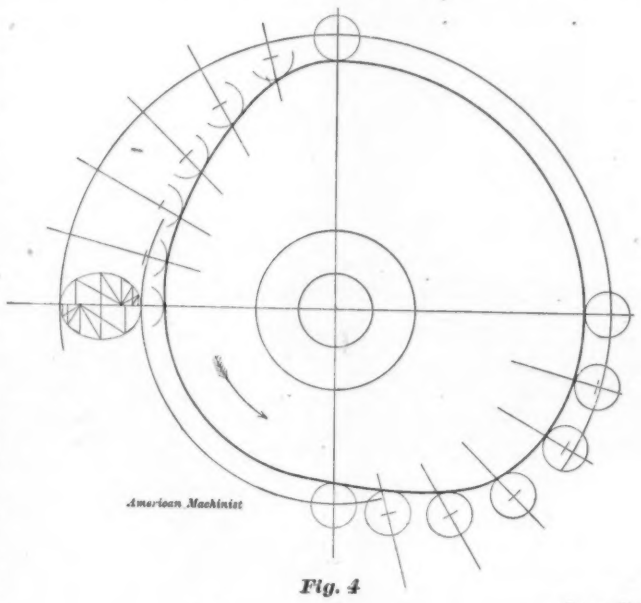


Fig. 4

The strain incident to giving a frictionless body a rectilinear motion by a crank, is that necessary to overcome the inertia of that body at the several points of its travel. During the first half of the stroke the inertia acts to resist acceleration, and during the last half to resist retardation. This resistance due to inertia is greatest, and in opposite directions, at the two extremes of the stroke, and nothing at the center of the stroke where it changes imperceptibly from strain in one direction to strain in the opposite direction. This is clearly illustrated by the inertia diagram shown in Fig. 1, in which $A\ B$ is the stroke and $A\ C$ and $B\ D$ the inertia at the two ends. The amount of inertia at any intermediate portion of the stroke is the vertical distance between the horizontal line $A\ B$ and the diagonal $C\ D$. But a body moved by a cam is not without friction, and the diagram illustrates only the resistance due to inertia. If we assume that the friction is $1\frac{1}{8}$ times the inertia at the beginning of the stroke, then if we lay off $C\ E = 1\frac{1}{8}\ A\ C$ and draw $E\ F$ parallel to $C\ D$, the vertical distance between $A\ B$ and $E\ F$ will represent the actual strain in overcoming both the inertia and friction by a crank movement. It will be observed that this strain is maximum at the beginning and minimum at the end of the stroke, and is never transferred to the opposite side of the pin. If the cam movement comes to a rest at the end of the stroke, then the only objection is the great initial strain, but if the cam reverses its movement, then there will be a sudden change in the direction of the strain equal to $A\ E + B\ F$, and a pound equivalent to this sudden change.

The friction is a constant quantity inherent in the construction, and cannot be changed, and I may say that I include in the friction all resistance to the cam movement other than inertia. The proper remedy is to decrease the inertia at the beginning of the stroke, and increase it at the end of the stroke, so that the line $E\ F$ (as a curve) will cross the line $A\ B$, and the distance $A\ E$ upward will be equal to the distance $B\ F$ downward. The way I accomplish this result is to substitute for a cam rise in crank time what I call a "cam rise in elliptical time."

To explain the application of this more clearly, I will first explain the construction for a cam rise in crank time, as shown in Fig. 2. First draw the lines $A\ B$ and $C\ D$, and with O as a center draw the arcs $E\ D$ and $F\ C\ B$ representing the inner and outer positions respectively of the pin operated upon by the cam. On the line $A\ B$, with $F\ E$ as a diameter, draw the semi-circle $F\ G\ E$. Divide this into any convenient number of equal parts, and drop the perpendiculars, 1, 2, 3, etc., to the line $E\ F$. Divide the angles of cam rise, $A\ C$ and $B\ D$, into the same number of equal parts, and draw radial lines, numbering them also 1, 2, 3, etc. Then with O as a center, and $O\ 1$ as a radius, cut the radial lines 1, 1, at a; with $O\ 2$ as a radius cut the lines 2, 2 at b, and proceed the same for c, d and e. With a, b, c, etc., as centers, draw circles representing the diameter of the pin operated upon by the cam, and then draw the cam curves tangent to these circles, the result is a cam rise in crank time

To draw a cam rise in elliptical time, I substitute the ellipse for the circle, and draw the radial (equal angular) lines 1, 2, 3, etc., through the focus F, as shown in Fig. 3. From the points where these lines cut the ellipse, I drop perpendiculars to the line $A\ B$ (which is equal to the cam rise), and the distances from the point A to these perpendiculars represent the amounts of cam rise. The application of this is shown in Fig. 4, in which it will be seen that the radial lines are drawn from one focus for the upper half, and the other focus for the lower half. The reason for this will be readily understood by remembering that the movement is outward in one case, and inward in the other. These two cam curves are compared in Fig. 5, in which the full lines represent elliptical rise, and the dotted lines crank rise. Transferred to a horizontal line and enlarged, these rises are shown in Fig. 6, in which S = the rise, and y = the less focal distance, or the distance $A\ F$, Fig. 3. As making $y = .5\ S$ brings the focus to the center, it is evident that the upper curve represents crank time. The other curves represent grades of eccentricity, which are indicated by the value given to y.

The problem is to locate the focus F, for on this depends the shape of the ellipse, and the proportions of the cam rise. To do this the friction or the resistance to motion, other than mere weight, must be a known or an assumed quantity. The notation for the general formulæ is as follows:

D = Degrees of cam rise.
S = Stroke of cam in inches.
$R = \frac{S}{24}$.
W = Weight moved.
F = Frictional resistance to moving W.
N = Revolutions of cam per minute.
$n = \frac{180\ N}{D}$.
x = Greater focal distance.
y = Less focal distance.
I = Inertia of crank motion.
I_1 = Inertia due to x.
I_2 = Inertia due to y.
$x + y = S$.

$$I = \frac{W\ R\ n^2}{2{,}933\ 54}. \quad (1)$$

$$I^2 = I_1\ I_2. \quad (2)$$

$$I_1 : I_2 :: x^2 : y^2. \quad (3)$$

$$I_1 = \sqrt{I^2 + F^2} + F. \quad (4)$$

$$I_2 = \sqrt{I^2 + F^2} - F. \quad (5)$$

$$I_1 = \frac{I\ x}{y}. \quad (6)$$

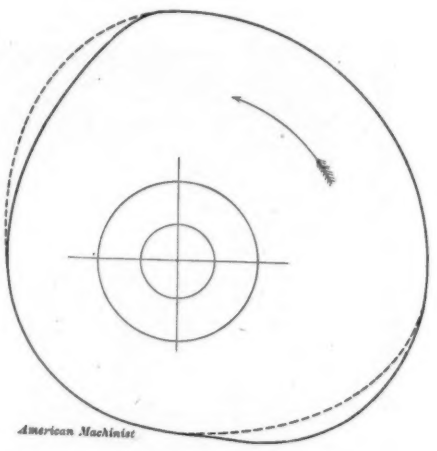


Fig. 5

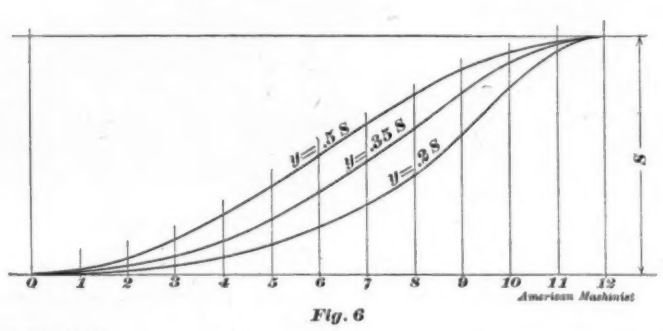


Fig. 6

CAM CONSTRUCTION.

$$I_2 = \frac{I\ y}{x}. \quad (7)$$

$$F = \frac{I_1 - I_2}{2}. \quad (8)$$

$$y = \frac{I\ S}{I + I_1}. \quad (9)$$

The only formulæ that need to be used in the calculation are (1), (4) and (9), the others being given to more clearly show the process by which the final result was reached.

The following table has been calculated on the assumption that $S = 10$ and $I = 100$. By its use it is only necessary to calculate the inertia by formula (1) and assume F, which may be readily done approximately by the known conditions under which the cam is to operate. With the ratio between these two quantities known the corresponding ratio between I and F of the table will give the ratio between S and y.

S	y	I_1	I_2	F	I	Strain.
10	2	400	25.	187.50	100	212.50
...	2¼	344.44	29 03	157 70	....	186.70
....	2½	300.	33 33	133.33	....	166 66
...	2¾	263 64	37 93	112.85	..	150 80
...	3	233.33	42 86	95.24	...	138.10
...	3¼	207 70	48.15	79.80	...	127 95
....	3½	185.70	53.85	65 90	....	119.75
....	3¾	166.67	60.00	53.33	....	113 33
..	4	150.	66 67	41 67	..	108.33
....	4¼	135 27	73.92	30.67	..	104.53
..	4½	122.22	81 82	20.20	....	102.02
....	4¾	110.50	90 50	10.	....	100 50
...	5	100.	100.	...	....	100.

The last column of figures gives the strain on the cam at the beginning and end of the stroke. At all intermediate positions the strain is a less quantity. If a crank movement be used when the inertia is 100 pounds and the friction is 187½ pounds, the initial strain on the cam would be 287½ pounds and the terminal strain 87½ instead of 212½ pounds each. Furthermore, the 87½ pounds strain would be on the same side as the 287½ pounds, and the reversal of the cam stroke would cause a blow of 375 pounds instead of passing imperceptibly from one to the other.

The assumption has been that the frictional resistance is uniform throughout the stroke, and this is practically the condition where friction is the only resistance beyond inertia. It often happens, however, that other resistance is encountered through a part only of the stroke. In such cases no general formula can be given, but each case must be developed on its own merits.

If we represent the radius of the inner position of the pin operated upon by the cam by R_1, then by making

$$R_1 = \frac{y}{\text{secant } \frac{1}{2}\ D - 1},$$

we will have a cam rise that, for the greater part of the stroke, approximates very closely to a straight line tangent to the smaller cam radius.

Projecting Drawings.

BY OBERLIN SMITH.

The writers of the recent essays upon the above subject seem to dwell particularly upon the doctrines of descriptive geometry, although some of them ring the changes upon other imaginative methods of conceiving what a drawing means, such as walking around the object represented, or climbing upon top of it, or burrowing underneath it, or looking at it through transparent paper, or through glass, or having its various sides depicted upon paper which may be supposed to be wrapped around it, and which afterwards may be peeled off, after the manner of skinning an onion, etc.

The imagination required to see things in mid-air, where they do not exist, is a very desirable quality which is possessed as a gift of the gods by many inventors, by chess players who can conduct several games at once with their eyes blindfolded and, in lesser degree, by ordinary geometricians, by well-trained draftsmen, by good whist players, and also (shall I say it?) sometimes, perhaps, by theologians and commercial travelers.

If we assume, however, that all makers and readers of drawings must, to a certain extent at any rate, possess and use this faculty, we may ask: *Does it pay, providing* a simpler process can be employed?

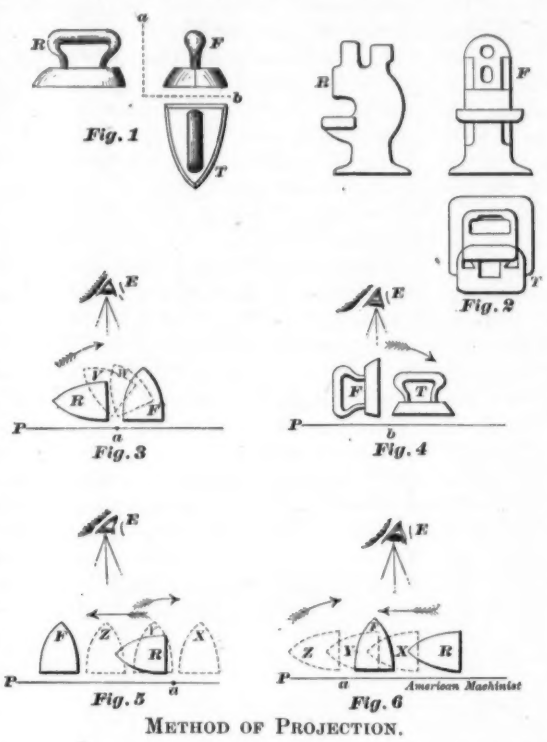
The question arises whether it is not much simpler and conducive to less mental effort, as well as less confusion, to merely consider a mechanical drawing as a representation of the object itself, laid upon the paper, or held at a small distance above it. Furthermore, what can be more simple than to imagine the view of another side of the object in question, as that same object rolled over upon the paper through perhaps 90 degrees of revolution, if the view be of an adjacent side? Assuming then that this is the simplest method, and the one that causes the least necessity for a stress upon the imagination, not only from the general nature of the case, and the dictates of common sense, but from the writer's experience with workmen of every sort, whom he has repeatedly seen holding small objects, as a nut or a hammer, for instance, over the bench and rolling them over so as to get a good idea of the appearance of the relative sides thereof, especially when called upon to examine a new drawing, let us for the time being abandon the terms "first-angle" and "third-angle" methods. As substitutes therefore I would, for want of shorter names, use the terms "direct-revolution" and "indirect-revolution" for the "first-angle method" and "third-angle method" respectively.

Referring to the annexed drawings, in Fig. 1 is shown an ordinary flat-iron, *R* being a right view, *F* a front view projected from *R* by revolution about the line *a* (preferably lying in the plane of the paper) as an axis, and *T* a top view, projected from *F* by revolving about the axis *b*. In Fig. 2 are shown similar views of the frame of a punching press, *R* being the right view, *F* the front view, and *T* the top view. These are arranged in the order in which I almost always put them in my own practice—placing each individual piece in detail drawings, also, in the same order in regard to the relative position of the various views.

In Fig. 3 is shown at *P* an edge view of the front of the sheet of drawing paper upon which Fig. 1 is drawn. A little way above the paper is shown the same flat-iron, which, although the bottom only is visible, I have marked with *R* for right view, and *F* for front view, to agree with Fig. 1, these being the views which would really appear when viewed from the eye at *E*, looking downward upon the paper. The axis of revolution *a*, of course, here appears as a dot. The direction of angular motion about *a* is shown by the arrow, and some of the successive stages of motion during the 90 degrees of revolution in question are shown by the dotted outlines *V* and *W*. In Fig. 4 is shown in like manner a view of the left edge of the drawing paper, the views *F* and *T* being respectively the same as views *F* and *T* in Fig. 1, the axis of revolution *b* appearing a dot merely as before. This is direct revolution pure and simple, which, as before stated, involves only the rolling over of the object on to its adjacent side. Such a process is easily conceived of by the non-geometrical mind, especially if the object is supposed to lie upon the paper in both views, which is near enough to the truth to enable proper conceptions to be attained. As a matter of actual fact, the object is usually supposed to be a little above the paper, as is shown, in order that when revolved the two views may not quite touch each other. This is easily understood by a workman, however, especially if he illustrates it to himself by holding some object in his fingers, which naturally raises it a little, and then turns it over.

In Figs. 5 and 6 are respectively shown similar views of the edge of the paper at *P*, with the same right (when regarded from above by the eye) view, *R*, as in the primary drawing. In order to get the front view of the flat-iron *R* in the position due to the "third-angle" or to indirect-revolution, as shown, two obvious processes of moving the object above the paper may be employed. One is as in Fig. 5, to revolve *R* up to the position shown in the dotted contour *X* (which by the other method would complete the operation) and then to slide it through various successive stages, two of which are shown at *Y* and *Z*, over to the position *F*. In Fig. 6 is shown the other process for effecting the same transformation scene. In this case the sliding is done first, through successive positions *X*, *Y*, etc., to *Z*, as shown by the straight arrow, after which the act of direct revolution, as indicated by the curved arrow, is performed, thus bringing *Z* up to *F*.

It seems to me, therefore, that if we desire a simplicity adapted to untortured, if not untutored, imaginations we must totally abandon for practical work the complexity of two ideal planes and their four ideal angles, with the conception of the object seen beneath the paper instead of above it, etc. If, further, we abandon the still more puzzling ideas of walking around or climbing over the object, or unfolding its skin, we will probably come down to the simple conception of the object, or a model thereof of the proper size, lying upon the paper. To get additional views, we must either revolve it directly by merely rolling it over or, by the method last described, we must both roll it over and slide it to a considerable distance from its original position. It does not appear to me, as probably it does not to the great army of my fellow believers, that there can be two answers to the question as to which is the simplest and therefore the best of these two methods.



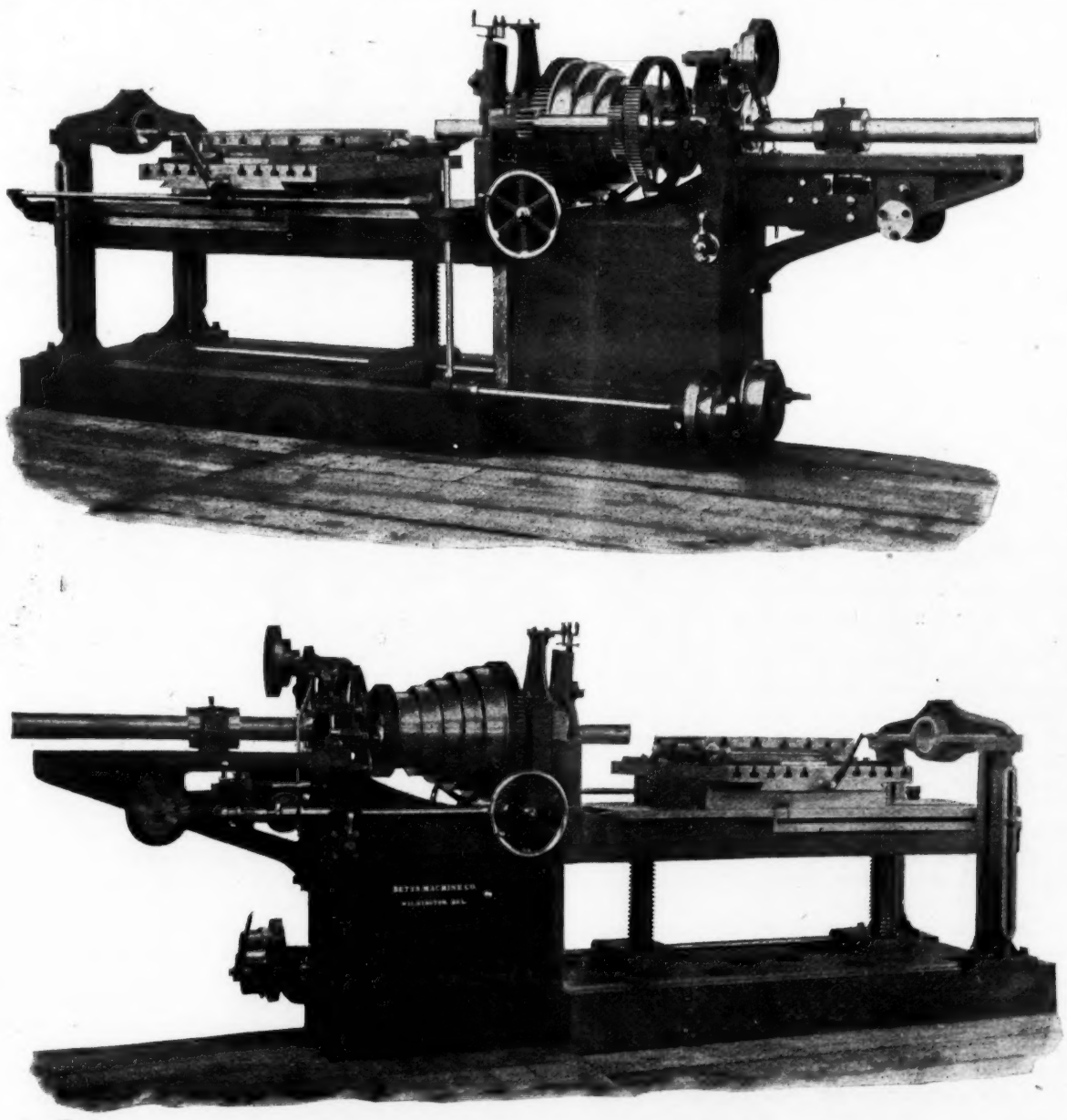
METHOD OF PROJECTION.

From the drawing reader's point of view, I know of no argument in favor of indirect revolution except that perhaps it is easier to remember that the front view is nearest the front of an object shown in top view, and that the right view is nearest the right end of the front view, etc., than it is to remember the converse of this proposition. I have not found, however, that anybody practically ever cared a straw about this. If a man wishes to remember by such an act of "association," it is very easy for him to get in the habit of remembering that the conditions mentioned are reversed. The advantages of remembering that each view is obtained by simply tipping the object over, are, to my mind, as before stated, greatly preponderant over the one just mentioned, as an aid to uniformity of memory.

In looking at this question from a draftsman's point of view, it has been argued by some of the "indirect" people that it is easier to project the various parts shown near the right side of a drawing a *short* distance to its right view, rather than to carry them all the way across to the other end, over a *long* distance. In the same way it is said to be easier to project the top parts of an object upward a short distance to a top view, rather than down below—as, for instance, from the upper part of *F*, Fig. 2, down to the view *T*. As a matter of fact, however, this does not amount to anything, as there are usually some projecting parts at the other end of an object which must also show, as, for instance, the base and bed of the press frame *F*, projecting in most places beyond the upper parts, as shown by the outer lines at *T*—these important lines all having been projected a less distance than would be the case with *T* above *F*. In the same way the right view of a lathe will really be easier to project to the left of the front view than as if put at the right end, because there happens to be some complicated parts, such as the back gearing, etc., at the left end, which usually project beyond the more simple shapes at the right end, such as the tail stock, etc. One would naturally think that with so long an object as a lathe the arguments of the indirectionists would have more force than with the majority of machinery, which would, on an average, have chunkier proportions, so to speak. In the two cases just cited, however, of the power press and the lathe, we have seen that the argument falls to the ground; and even where there would, on the whole, be shorter lines of projection the matter is of little practical consequence, as the tee-square and other tools used are supposed to be in good enough condition to draw the various lines as accurately parallel as is necessary to produce a good picture. The projecting lines, therefore, will also be sufficiently accurate—and especially is this the case where use is made of the cross-ruled drawing paper which is becoming all the time more popular.

In some recent articles upon this subject, it has been stated that the majority of our best shops are now using the third-angle, or indirect, method. If it be the fact that the first-angle, or direct, method has been gradually dying out, the melancholy probabilities are that it will die still more. When its disease becomes absolutely mortal, it will be only the proper thing for the army of "direct" people to gracefully surrender to the larger army of "indirect," learning the habits of a lifetime over again, that a common practice (even if not so good as is something else, in the eyes of some of us) may obtain throughout the earth. *Such uniformity is certainly of great importance*, not only as a matter of convenience, but of actual saving of expense in the avoidance of mistakes, etc., and should undoubtedly be aimed at by all of us as early in the future as is possible.

This question of which way to project cannot in the nature of things be of such very great importance in itself, like theology, or so many good people would not differ regarding it Let us then all strive to come to a common practice in the matter and meet upon common ground of direct revolution if we can, or indirect if we must. Let us remember, however, that America is all the time becoming less provincial and that this common ground should be international, rather than merely occidental. It is to be hoped, therefore, that the gentlemen who are taking a census, so to say, of the representative shops that make and use drawings, will make their statistics of real value by consulting *all*, above some certain size, not only in this country, but in Europe also.



HORIZONTAL BORING MACHINE.—SEE PAGE 564.

A Horizontal Boring and Drilling Machine with Special Features.

The adjoining illustrations show the front and back views of a large horizontal boring and drilling machine, recently gotten out by the Betts Machine Company, of Wilmington, Del.

The machine is double back-geared, giving 15 changes on the spindle, which is of cast steel, 5 inches in diameter, and has 30 inches movement through the cone, with provision for increasing to 60 inches with one movement of spindle in the feed rack. The steel spindle can be driven in either direction; it has a full bearing through the cast-iron spindle at all times, with a quick movement by hand through a rack and pinion.

The feeds are automatic, varying from $\frac{1}{100}$ to $\frac{35}{100}$ of an inch, with every graduation between these points, and the spindle can be fed in either direction without reversing its motion.

The table for work is 10 feet long, elevated by two screws with worm wheels and worms, which are driven by power; the table carries a saddle which has a movement parallel with the main spindle, and on this saddle is a cross table, 48 inches by 60 inches, for securing work, which has a horizontal movement at right angles. Upon this table is mounted a graduated circular table, with hand adjustment through worm wheel and worm, convenient for angular boring and drilling.

The tables can be lowered until the rectangular slotted table is 33 inches from the center of spindle, and by removing the upper tables this distance can be increased to 41½ inches, giving the machine a swinging capacity of 83 inches.

The rapid movement of the spindle and the releasing or engaging of the automatic feeds can be operated from either side of the machine by means of hand wheels and levers, which are all within easy reach. This feature of operating from both sides results in a great saving of time on a large machine.

The front view of the machine shows the interlocking arrangement between the spindle and the table-feed movements; this arrangement prevents any complication that might arise from the two feeds working simultaneously. The front view also shows a special hand device for spiral grooving.

The back view shows the reversible power-feed mechanism to the rectangular table; also the arrangement for double back-gearing.

Total weight of the machine, 34,000 pounds.

Direct-Acting Hydraulic Air Compressor and Vacuum Pump.

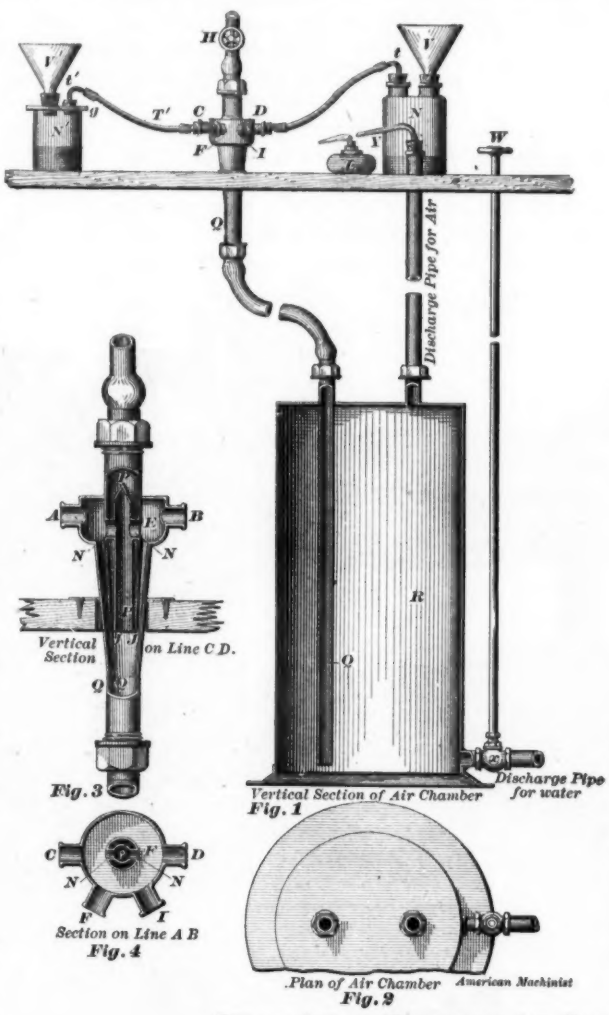
BY W. F. DURFEE, M. E.

The "hydraulic air-compression system," described in the AMERICAN MACHINIST of June 20th, as the invention of Mr. C. H. Taylor, of Montreal, appears to be a slight modification of that very ancient mechanism for "raising the wind" called a *trompe*. Whether Mr. Taylor's modifications are really improvements, carefully conducted comparative experiments can alone determine.

Fig. 0 is a vertical section of one form of *trompe*. The water which operates it is discharged from a pipe *A*, into the funnel top of the vertical tube *C*, near the top of which are several inclined apertures for the admission of air, two of which are seen at *e e*. As the water descends the pipe *C*, it draws in air through the apertures *e e*, and carries it downward into the closed chamber *D*, in which the water falls upon some obstacle, and is thereby thrown into spray, from which the air separates and rises to the top of the chamber *D*, and the water collects below and is discharged through a cock; the air being conveyed where desired through a pipe *B*. There are a variety of forms of the *trompe*, which differ from each other chiefly in the method of receiving the air at the top of the tube *C;* in some cases, instead of the lateral inclined openings, vertical straight tubes surrounding the stream of inflowing water have been used; and, in fact, *trompes* have been made to operate without either lateral openings or vertical air tubes.

The *trompe* is among the earliest mechanisms for furnishing air to furnaces and forge fires. It is believed to be much older than Hero (150 B. C.); it is mentioned by Pliny (A. D. 76); Kircher, in his *Mundus Subterraneus* (1665) gives a figure of it, and in his *Musurgia Universalis*, he shows its application to the blowing of organs; in which, however, he is anticipated by *Branca* (1629), whose illustrations represent it as blowing organs, and also forge fires. In the *trompes* shown by Branca, the air is introduced by vertical tubes in the center of the funnel top of the upright pipe *C* (Fig. 0).

Although the *trompe* as a mechanism for compressing air can boast of such a hoary antiquity, it is only within recent years that its value as a means of producing a partial vacuum has been recognized. In the year 1869 the writer designed a modification of the *trompe* for use as "a vacuum pump and table blow pipe." This was believed at the time to be the first use of the principle of the *trompe* for exhausting air; but as a matter of fact, Professor Bunsen had employed this principle in the construction of his "filter pump" a few years before, but his apparatus was not adapted for use as a blow pipe.


Discharge Pipe for Air
Vertical Section on Line C D.
Section on Line A B
Vertical Section of Air Chamber
Discharge Pipe for water
Plan of Air Chamber
American Machinist
Fig. 3 Fig. 1 Fig. 2 Fig. 4

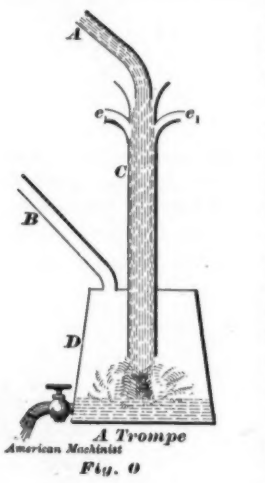


Fig. 0

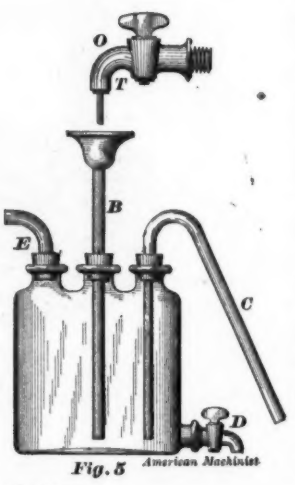


Fig. 5

DIRECT-ACTING HYDRAULIC AIR COMPRESSOR.

The following description of "a combined vacuum pump and table blow pipe" on the principle of the trompe, is quoted from a paper read by the writer at the Chicago meeting of the American Institute of Mining Engineers, in May, 1884.

Fig. 1 is a general elevation of the apparatus, the air chamber being sectional. Fig. 2 a plan of the air chamber; Fig. 3 a vertical sectional elevation of the vacuum pump, the section being on line *C D* of Fig. 4 which is a horizontal section on line *A B*, of Fig. 3.

The vacuum pump is constructed of copper. The vacuum chamber *E* is supported upon the upper expanded end of a vertical pipe *Q*, and is provided with four nozzles *C, F, I, D*, Fig. 4, two of which are shown in section at *A B*, Fig. 3.

Passing vertically through the center of the vacuum chamber *E*, is the water supply pipe *P*, whose lower extremity incloses an internal pipe *p*, which is supported, and placed in communication with the vacuum chamber *E*, by means of the two elliptical nozzles *n n*. The upper end of the pipe *p* is closed by a conical cap, and its lower end is in the same plane with the extremity of the water supply *P*, within which it is placed. The relative sizes of the pipes *P* and *p* are such that an annular adjutage, one-sixteenth of an inch in thickness, is formed between their lower ends, through which the water from the supply pipe *P* passes into the pipe *Q*, drawing any air that may be in the vacuum chamber *E*, and the upper conical part of the pipe *Q*, along with it; the air in the vacuum chamber *E*, having free access to the interior of the hollow cylindrical jet, through the nozzles *n n*, and the internal pipe *p*.

When the apparatus is used to facilitate the operation of filtering, either or all of the nozzles *C, F, I, D* are connected by rubber tubes to the vessel which is to receive the filtrate. In Fig. 1, two kinds of receiving vessels are shown. That on the right is a common two-necked bottle *N*, to whose right-hand neck is fitted a cork, through which is passed the stem of a glass funnel *V* containing the filter paper and solution to be filtered; the left-hand neck is provided with a cork, through which is passed the lower end of a bent glass tube *t*, to whose outer extremity is attached the right-hand end of the rubber tube *T*, its other end being connected by a short glass tube to a perforated cork adapted to the nozzle *D* of the vacuum pump. The form of receiving apparatus shown on the left of Fig. 1 comprises a beaker *N*, of common form, having its lip ground to an air-tight contact with a glass cover plate *g*, provided with two holes to which are fitted corks for the reception of the filter funnel *V* and the bent glass tube *t'*, which last is connected to the nozzle *C* of the vacuum pump by the rubber tube *T'*. Whenever the apparatus is employed as a vacuum pump, such of the nozzles *C, F, I, D* (Fig. 1) as are not connected with filters must be closed with cork stoppers, as shown at *F I;* the cork in the upper end of the discharge pipe for air must be removed, and the valve *X*, in the discharge pipe for water, must be kept wide open. This adjustment allows the mixture of air and water, which is discharged from the vacuum pump through the pipe *Q* into the air chamber *R*, to separate and pass away without resistance through the respective discharge pipes for air and water. The rapidity and power of the action of the vacuum pump may be readily adjusted at will by means of the valve *H* (Fig. 1) which controls the amount of water admitted to it in a unit of time.

In Fig. 1, the apparatus is represented (for the purpose of compactness of illustration) as acting at the same time as an exhauster and compressor of air, although in practice it is never used in this way. When it is to be used as an air compressor, it is adjusted as follows:

The cork stoppers are removed from the nozzles *C, F, I, D*, thus allowing the air free access to the vacuum chamber *E* (Figs. 3 and 4); the valve *X*, in the discharge pipe for water, is partly closed, and a cork having a bent tapered glass tube *Y* (Fig. 1) to serve as a blow pipe tuyere, adapted to it, is inserted in the upper end of the discharge pipe for air. This tuyere pipe *Y* can be adjusted vertically by moving it up or down in the cork through which it tightly passes, to adapt it to the hight of the blow pipe lamp *L*. In case it is necessary to use the blast at a distance from the upper end of the discharge pipe for air, one end of a rubber tube of a convenient length may be attached to this pipe, its other end being provided with a tuyere, which may be held in any suitable support, and thus blast may be supplied to any form of lamp or other heat generator.

The apparatus being adjusted as described, all that is required to put the blast in action is to turn on the water to the vacuum pump by means of the hand wheel *H* (Fig. 1). The water as it passes through the hollow cylindrical adjutage *j j* (Fig. 3), draws the air through the four open nozzles *C, F, I, D*, and carries it through the pipe *Q* (Fig. 1) into the air chamber *R*, in which the air and water separate, the former finding an escape through the discharge pipe for air and its attached tuyere, and the latter passing off through the discharge pipe for water. It is desirable that the air chamber *R* should be located ten or twelve feet below the point of discharge of the blast, whose intensity is influenced in a great degree by the distance from the vacuum chamber to the bottom of the air chamber, and also by the pressure of the water supply through the valve *H*. The volume of the blast may be regulated, within its maximum limit, by means of the valve *H*, and its pressure within the same limit by properly adjusting the valve *X* by the hand wheel *W*.

Another form of blow-pipe apparatus, dependent for its action on the principle of the *trompe*, is illustrated by Fig. 5. It was first constructed by the writer hereof in the year 1868, for use in the laboratory of the steel works at Wyandotte, Mich. It has the advantage of being readily arranged with the means usually at hand in a well-equipped laboratory. It consists of an ordinary Woolf bottle, *A* (Fig. 5), to whose central neck is tightly fitted (by means of a cork) a funnel tube *B*, extending nearly to the bottom of the bottle. To the right-hand neck is fitted a siphon *C*, whose inner end is very near the bottom of the bottle. (In case a two-necked bottle having a tubulation on one side is available, a small cock, as shown at *D*, may be substituted for this siphon.) The left-hand neck of the bottle *A* has adapted to its cork a curved pipe *E*, to which may be attached a rubber tube for conveying the air in any desired direction, for use with a blow pipe, or for other purpose. When it is desired to put this apparatus in operation, it is placed under a hydrant cock *O*, which is provided with a glass tube *T*, slightly smaller in internal diameter than the funnel tube *B*, and through the tube *T*, a regulated stream of water is discharged into the funnel tube. This stream drags down into the bottle *A* a large volume of air, which, separating from the water, is discharged through the pipe *E*, while the water finds its escape either through the siphon *C*, or the cock *D*, as the one or the other is used in the construction of the apparatus.

In the course of my practice I have had occasion to construct several of the vacuum pumps described, and they have given entire satisfaction in use. At the time when the first one was made (the summer of 1869) I

had not learned of anything of the kind being employed, but in a few months I was told that what is known as the "Bunsen filter pump" was then in use in a few laboratories, but as that did not furnish a blast, and could only be used with one filter, I am disposed to believe that the idea of the combined apparatus above described, as well as its realization in practice, was original.

Modern Furnace vs. Cupola Practice—III.

By THOS. D. WEST.

TAPPING-OUT AND STOPPING-UP.

Tapping a furnace, as far as it relates to skill, responsibility and hazard, is an important operation, and should be understood by the manager and molder in founding. It has taken much time, study and experience to attain the present perfection in controlling the output of a modern furnace. The history of furnaces could show many disasters in "breakouts," "boils" and explosions.

When all is working well about a furnace everything seems very simple and as if taking care of itself, but it is when all does not go well that one is impressed with the fact that furnacing is often more like Hades let loose than a paradise of comfort, ease and pleasure. An observing founder standing at a distance watching a furnace being tapped would often be at a loss to understand why a cupola cannot have its "breast" stopped the same as the "notch" of a furnace. The founder often has trouble with cupola tap holes, which when once started to work badly will often continue to do so throughout the balance of the heat. The secret of the furnaceman being able to stop a notch in the way it is generally done, is that the metal, when all is working well, is left lower than the notch hole as illustrated at the levels *X* and *O*, Fig. 5. How the metal goes down to such a low level as shown, is a puzzle to the founder who has never seen a furnace. The tapping hole *K* is generally made at an angle something as shown. After the metal has run out all it will do by force of gravity, the blast pressure is increased above the ordinary to drive or siphon it out, as called by some, to about the level shown at the dotted line *O*. With the weight of stock bearing down on the molten mass in a crucible and a blast pressure of 10 pounds to the square inch, it seems reasonable to expect the results described. We know the weight of stock and pressure of blast exerts such a driving-out influence, from the fact that when about two-thirds of the pig beds are poured, the metal will often almost stop running, at which point the blast pressure being increased a third more metal will often be forced out, and to tell how much lower than the level of the tap hole the metal has sunk, is easily done by inserting a rod down the notch into the liquid metal until the bottom is touched, when by pulling the rod out the depth of metal and slag can be judged. It is claimed by furnacemen that the more acute the angle of the notch, so as to carry its opening lower into the crucible, the more metal can be syphoned out in tapping a furnace. A question to suggest itself at this point is the reason for having such a body of metal below the level of a notch hole. The great depth sometimes attained is not really desired, but is caused by the liquid mass burning out the bottom brickwork. When "blowing-in" a new furnace, the bottom bed of the hearth or crucible is not much over four inches below the level of the notch, but continual running and "fast driving" of a furnace soon cuts out the bottom lining, so that it is no uncommon result for metal to burn the bottom down three to four feet below the level of a notch, as indicated by the dotted line *S* in Fig. 5. Some furnacemen claim it is not until a bottom is cut down for a foot or two so as to have a body of metal which can be forced out at any tap, that the best output and quality of product can be obtained. Often has a furnace cut the bottom out to such a depth as to force an opening for metal to pass downward through the ground or outward through the sides, something as indicated by the lines *N*, *M* and *H*. The havoc such an escaping body of metal can make, if bursting out as it often has into a reservoir of water which is always more or less deep around the hearth of a furnace as at *M*, can be but partly conceived.

The mass of liquid metal in the bed of a furnace may often weigh 50 to 100 tons. This often solidifies, lies in a furnace until it may be torn down, or the hearth portion removed to permit breaking up by dynamite. It has happened that, through a furnace "getting off" or working badly, the bed of metal has solidified above the level of the notch, so that to tap the metal out of the furnace such would have to be drawn off at the flushing or slag hole at *A*, Fig. 5. Some furnaces have run for a week or two in this manner before they were able to get the solidified mass melted down so as to again draw metal from the notch hole. A furnace

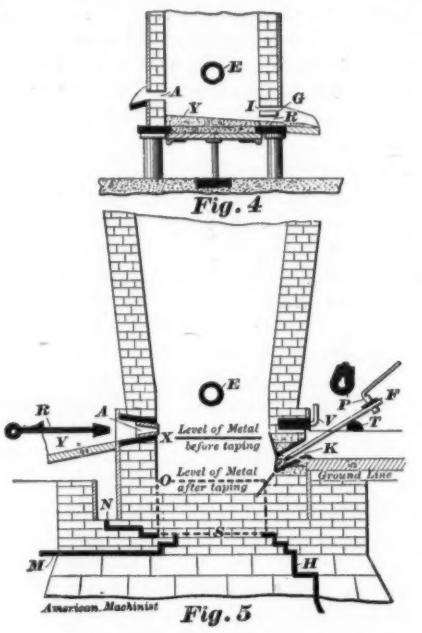


Fig. 5

Fig. 6

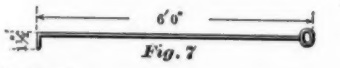


Fig. 7

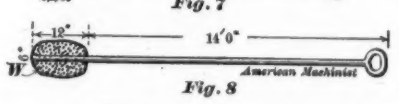


Fig. 8

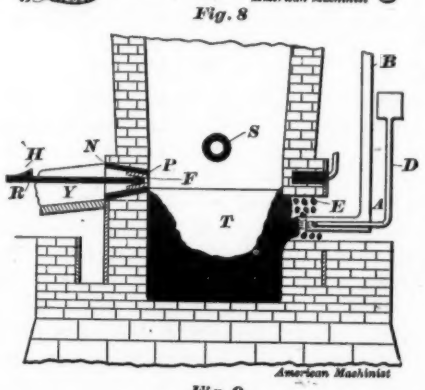


Fig. 9

CUPOLA PRACTICE.

in this condition must be tapped much oftener than when it can be tapped at the regular notch. It is often surprising how rapidly, through a furnace getting cold, the bed of metal in the hearth will solidify, and then again how when a furnace is working hot, how it will often cut out such a solid mass of iron, but generally, like all workings of mechanical affairs, the evil is prolonged more than the good is hastened, when trouble once begins.

Fig. 9 shows some effect of a chill in a furnace causing metal to solidify around and above the notch. This is one form taken and another may be, instead of having a chill all around the sides with liquid metal in the middle, to have but one side solidify while its opposite is in a fluid state. Solidification of such masses generally occurs by reason of scaffolding, cooling off the furnace, and then letting a mass of chilled stock slip down to the tuyeres, or lower into the hearth. There are two forms of such evils to result from a slip, the first being the solidification of metal as above described, and the other what is called a "lime set," which is generally caused by reason of a furnace carrying a heavy burden of limestone, and the furnace becoming cold from scaffolding, or any other bad working, chills the lime so that it becomes too thick to flush out, and sets in a solid state in the crucible or at the tuyeres. Furnacemen generally fear a "lime set" more than that of molten metal solidifying, for the latter can be melted away much more readily than the former. Lime sets have been so serious that furnaces have had to "blow out" to remove them.

A method sometimes employed to gain access through solidified iron which might close up a notch so as to prevent its being tapped is that illustrated by the blow pipe seen at *A*, Fig. 9, which as used in this case, is simply a 2-inch gas pipe leading from the hot blast pipe (cold blast can also be used) into which a ¼-inch pipe *D* carries a stream of coal oil igniting at the outlet, and there making sufficient heat to melt the iron or enable it to be knocked away until sufficient space is made to admit of the blast and metal blowing out to farther cut away the solid iron to a point warranting replacing of the notch for regular working. In some cases a coke or coal fire will be encased in front of the blow pipe, and the stock to be cut away as illustrated by the small lumps of fuel seen at *E*, Fig. 9. The principle involved in this process is one which may be often practically applied by the founder in preparing a casting to be burned by bringing the point of fracture to almost a molten state, thereby saving labor of melting and handling a large quantity of liquid metal, and also may at times be found of value in assisting to cut away heavy bodies of iron that might be found almost impossible to be otherwise manipulated. In using this device, to cut out the notch of a furnace, great care is exercised, as it may cut through the chilled material and without warning burst out with such a force as to empty the furnace in a few moments. Men have been struck by such a breakout and almost buried alive in a pool of metal before assistance could be rendered them.

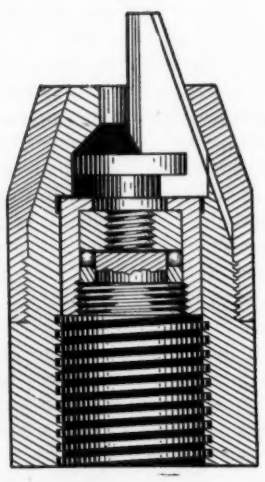
When all is working well with a notch of a furnace, the process in tapping is to first take a pointed bar and prick into the stopping clay, starting a hole as seen at the entrance *K*, Fig. 5, the "keeper" being careful to give it the shape and angle desired. As the clay is loosened, a ⅝-inch rod having a flat lifter about 1½ inches square on its end, as seen in Fig. 7, is used to pull the loose clay up out of the hole, which is generally made about 4 inches in diameter at the top, tapering down to 2⅝ inches at the bottom. Pricking by hand bars and lifting out the loosened clay is continued until the solid clay shows by its red heat that its thickness preventing the metal from bursting out is not over 3 inches, then a steel bar about 1¼ inches diameter having a sharp point is placed, as shown in Fig. 5, the upper end resting on a piece of pig metal thrown across the top of the iron trough, as seen at *T*. A sledge is now used at the end *F*, the bar in the meantime having its point guided by hand so as to cut around the edge of the hole. This is continued until metal is seen to commence oozing out when the bar is then driven through the started body of the clay into the metal seeking to force itself out. The bar is then pulled out, in which movement should there be any difficulty experienced a device as seen at *P* is used, which by sledging on the end of the wedge shown backs the bar out of the notch. Sometimes, instead of the affair shown, a stout ring will be used, and by inserting the wedge as shown a similar result is insured. This device is a simple affair, and would suggest to many founders a remedy for difficulty often experienced in pulling back bars driven into the breast, tuyeres or slag holes of a cupola.

After a bar has been removed from the notch, the metal generally flows out with a fair speed, but should lumps of dross or fuel impede its passage, a smaller bar than the one used to tap it is generally inserted in the notch hole, and by working it up and down, the passage is eventually cleared so as to permit the flow desired. It is not infrequent that the metal rushes out with too great a speed, often doing so with an unexpected burst, so as to strike the "keeper" with a spreading sheet of rushing metal if he is not carefully on his guard. An arrangement generally used at every tap to assist in lessening the force of the stream is a stopper as seen at Fig. 8; the end *W* being held at the mouth of the notch, can, if there is not too great a force, often almost stop the escape of metal. This stopper is made by rolling a 1¼-inch rod in a stream of slag as the furnace is being flushed out. Should the metal force itself out too fast at any time during a tap, the blast is slackened or stopped, until the metal has flowed off all it will of its own gravity, when the blast is again put on, and the increased pressure then drives out the metal and slag as above described. This end achieved, the blast is then completely shut off, and the process of stopping the notch is commenced, and proceeded with as rapidly as possible in order to prevent loss of time in making iron. The first thing done is to throw a sheet-iron plate across the top of the iron trough; which, covered over with sand, protects the men from the heat of the trough, and permits them to come directly over their work. The notch at this stage greatly resembles a crater that has died down from vomiting its lava. Lumps of dross and fuel will be found sticking to its sides, which have been greatly increased in area from the effects of the "blow." A bar is used to loosen this *debris*, and then an iron scoop pulls it out of the notch hole. After this *debris* has been removed as well as the inflowing slag will permit, the bar is again used to push down into the crucible any lumps which might be sticking to the sides of the notch, and a bar of the same shape as Fig. 7, only made of round iron, is now used to press down into the crucible the dross and slag which endeavor to rise to fill the notch hole. This done, the bar is hastily removed, and men standing with two shovelfuls of clay toss it into the notch hole, the clay is then quickly rammed downward as far as possible with the rammer rod just described. After as much clay is pressed downward with these rammers as is found possible, then a round stick about 3 inches in diameter at the small end and 3½ inches at the top, having a ring to prevent sledging splitting the timber as seen at Fig. 6, is inserted into the notch and driven with two sledges down to the bottom, thus driving the dross and clay back into the crucible, as far as possible, to make a solid filling of clay in the notch at its bottom. This method of packing having been performed for half way up the notch, the packing stick is removed, the blast started and the balance of the notch is then filled with clay packed with hand rammers. A stream of hot blast is now turned on the top of the notch and the clay grouting used to coat the iron trough, so that at the next tap there will be no dampness to start a "boil." This is a plan original with the furnace shown as far as the writer is informed.

It is not every kind of clay that will answer for stopping a notch. It must be of a quality to withstand fire to the best possible degree. Some use a good grade of fire clay, others will grind up old crucibles to mix with the fire clay in an effort to improve its resisting qualities. The clay is mixed to a consistency about like that found good for cupola work, and in some places is prepared in pans crushed by heavy rollers. A cooler is generally placed over a notch, as seen at *V*, Fig. 5, and after a furnace has been tapped, and the iron commences to flow, a cover composed of fire brick held in an arch shape by a cast-iron cover, is swung by means of an iron arm close up to the furnace front at the cooler *V*, and let rest on the edge of the trough. Any space between this cover and the furnace shell is closed by means of sand being thrown around this section. This cover prevents the metal and slag from blowing up against the shell of the furnace to burn it out.

The success of stopping a notch being due to the fact of having the metal lower than the level of the notch, affords the furnace an

advantage not permitted to the cupola. Conditions in the latter calling for a bottom drop every heat make it most desirable that no metal should remain in the bottom of a cupola when a heat is finished. For this reason the bed of a cupola, as seen at *Y*, Fig. 4, is generally made on a slant, and the tap hole placed at its lowest level, as seen at *R*. With such an arrangement, when difficulty in tapping and stopping once commences, it often causes the "cupola tender" much harassing labor, and the founder loss in casting. Some furnacemen might suggest placing a tap hole on an angle something after the line seen at *G*, and then, at the end of the heat, breaking away into the bottom to give a hole on a level the same as *R* to drain the cupola so that no iron will be lost or spattered at the "bottom drop." Conditions in many foundries demand that a tap hole in a cupola be opened and stopped at intervals often not five minutes apart, and, again, a tap hole has often to be stopped when there is considerable of a head of iron in the cupola above the top of the tapping hole. This is a feat a furnaceman is not called upon to achieve, and if he were, it is very doubtful if it would be possible for him to completely stop the flow of metal. When a furnace is once tapped, it runs its course until all the metal is forced out much below the level of its notch, and the furnaceman should give the founder some credit for often facing and stopping a stream of metal rushing with no inconsiderable force out of a tap hole. There is one way a founder can often, in cases where it is difficult to obtain a good clean-working tap hole, secure one which will work satisfactorily, and that is by raising the tap hole above the bottom, as illustrated by the hole *I* seen above *R* in Fig. 4. A way to do this when a cupola breast is causing trouble, is to dig out the breast clean to the fuel, then stop the blast and quickly pull away any droppings of metal or slag which might be trickling over the bottom, and press down clay an inch or two thick all over its surface, on which then set a plug to form the tap hole, after which the breast is quickly rammed in after the usual practice. This method raises the tap hole above the level of the fluid metal, and provides an inch or two inch space for it to rise before the level of the tap hole is reached, then, before dropping the bottom, dig down to the bed's level, as above described. In some cases the metal not dropping very fast, or slag making its appearance after the blast has been shut off, it may be practical to form a good, new breast on the old bed, but in either case, where trouble is experienced with a bad breast, it is generally advisable to stop monkeying with it, dig out the old breast, shut off the blast, and form a new breast as quickly as possible, for a tap hole that will give trouble for half an hour often continues to do so until the end of the heat.



An Easily Tightened Drill Chuck.

We illustrate herewith an improvement in drill chucks, the invention of Mr. Ross M. Russell, foreman of the Stow Manufacturing Co., Binghamton, N. Y. It is a familiar experience in the shop that some drill chucks that are in other respects excellent will not hold drills tightly enough, and the drills consequently cannot be made to do their full duty. The life of many a chuck is shortened, and it is to be feared the temper of many a workman is overstrained by repeated and ineffective use of the spanner. In the type of chuck illustrated the jaws are tightened by forcing them out endwise from the chuck, each jaw acting as a wedge, one face of which is in contact with the shank of the drill, while the other face of the wedge is against the interior surface of the conical cap of the chuck, and the reason why the chuck cannot be effectively tightened is on account of the pressure against the end of the jaws to force them out, and the consequent friction at that point. Mr. Russell, by the introduction of the series of little balls seen in the cut, and the hardened surfaces for the annular ball race, gets rid of this friction, or so reduces it that the chuck may by the bare hand be tightened as much as may be desired for any purpose. The changes in the details of construction made necessary by the introduction of the ball bearing will be understood without further explanation. We are assured that chucks embodying this improvement have been in constant use for eight months with complete satisfaction.

LETTERS FROM PRACTICAL MEN.

Making Chips.

Editor American Machinist:

Had a certain foreman got hold of you, Mr. Editor, shortly after your editorial in the issue of May 30th, on "'Hoisting' the Shafting Down," perhaps you might have modified your views on making chips. It is well enough to say that other tools which are not pre-eminently chip producers are taking the place of the engine lathe, but the main object of our machine tools is to remove the superfluous metal in the least possible time. In the older days deep cuts and fine feeds were the rule, while to-day we use shallow cuts and very coarse feeds. The castings or forgings do come nearer to size, but we now wish to finish them all over at once. The element of handiness does count, but after all the particular points which you say are "harped upon" come into play when once the piece is fastened to the machine.

In a shop which has started up with a new plant and contains tools of several makes, I have had a chance to watch their performance. One 38-inch lathe of a well-known make gave, by its substantial appearance, every promise of doing heavy work. The pulleys were large, spindle well proportioned, and the gearing heavy and strong, yet we have had considerable trouble with it, due to lack of attention to some of the details. The only way in which the tail spindle can be oiled is to run it out, oil it and then draw it back. By this process most of the oil lubricates the front end of the tail stock instead of the spindle. This is a common fault in lathes, and with a long spindle the oil does not get in to the back end. The compound rest has a power feed which is so arranged that by no method save taking it apart can the screw or internal gearing be oiled. The ways have the same handy provision for oiling as the tail spindle and with as admirable results, save that the oil in this case lies along the lathe bed, keeping it from rusting.

A lot of columns and plates for a building job came in and had to be taken at a low figure. Still, as this lathe seemed amply heavy for the work, the job was accepted. The trouble began at once. The lathe seemed unable to carry the cuts, $\frac{1}{8}$ inch or $\frac{3}{16}$ inch deep and $\frac{1}{4}$ inch feed. It was found that the thrust bearing block at the end of spindle was too light, and let the spindle and cone pulley jam against the back end of the head stock. By tightening up this bearing things went better, until on stopping the lathe something snapped, and we found one of the lugs of the block had broken off. As we were in a hurry, a heavy planer clamp was substituted for the lug and did duty for some time. A few days afterward the cross feed refused to move. Investigation showed one of the bushings glued fast to its spindle. A heavy sledge was the only persuader that could get them apart. Both pieces were of soft steel, and as the provision for oiling this spindle was a poor arrangement, the inner end went dry with the above result. It is an interesting problem wondering what next will give out.

A 26-inch lathe of another make seemed a serviceable tool, but on trying to cut some worms $3\frac{1}{4}$ inches diameter, 3.2 inch pitch, quadruple thread, of Bessemer steel, the segment carrying the intermediate feed gears fell apart. This casting, which looked solid and heavy while in position, was found to be cut away by bolt holes and slots so as to leave very little metal. The worms were then taken to a special 16-inch lathe and finished in quicker time than we had been able to do in the 26-inch lathe.

One planer, a 36"x36"x12 ft., has the rack and pinion feed. The rack is connected by a heavy link to a stud which is adjustable for width of feed. This stud slides in a slotted disk, is tapped, and is moved away from or towards the center by a screw and hand wheel. The stud was of brass, about $\frac{3}{4}$ inch diameter, and fell apart one day just when a hurried job was on the planer. A steel one now replaces it, and we hope it will stand the work.

Another machine, a special 30-inch chucking lathe, which also gave promise of lots of work, gave out in its feed works. The gears were too light. Steel replaces the cast-iron gears as first used.

Perhaps you did not mean that handiness of manipulation counted for more than ability to take off chips, but such was my impression. Handiness of manipulation counts for a good deal, but except in very small work the time consumed in removing the metal is the larger proportion of the total. WM. SANGSTER.

Jamaica Plain, Mass.

[However it may be with a lathe, an editorial should certainly be a chip producer, and "Hoisting the Shafting Down" seems to be working all right in this respect.—ED.]

Ring and Chain Oiling.

Editor American Machinist:

The communication of Mr. R. D. O. Smith, in your issue of June 27, 1895, denouncing the use of chain and ring oiling pillow blocks, should not, I think, go unchallenged. My experience with chain oilers has been very limited, so I will pass them by; but Mr. Smith makes no distinction and classes both the ring and chain oilers as equally bad. In our electric station we are using the ring oilers under the most severe conditions with excellent results. Fifty feet of our line shaft, $6\frac{7}{16}$ inches diameter, 24-inch pillow blocks, running 340 revolutions per minute, is oiled entirely by ring oilers, and a hot box is unknown. We have a 1,350 light alternator running 1,100 revolutions per minute, and an 80 horse-power generator running 900 revolutions per minute, both oiled with ring oilers; the boxes on these machines run "hand warm," due to the heat from the armatures, but were never known to run hot. The oil in the ring oiling boxes is changed once a month, and the dirty oil put in the filter and again used until it is worn out. We have other electric machines of the earlier type which have given us a great deal of trouble through hot and melted boxes, and which I heartily wish were fitted with the despised rings. There are rings and rings; good rings have their inner circumferences bored true; if there are flat spots the rings are apt to stop traveling, whence probably arises Mr. Smith's dislike of them.

West Superior, Wis. A. A. CROSS.

How Does the Corliss Engine "Get There?"

Editor American Machinist:

Your number of 13th of this month contains the reproduction of a communication to *The London Engineer*, and headed in your valuable paper "The Corliss Engine Gets There—But How?"

The writer of the article having only the object to ask some one to tell him the reason why, we have, at once, tried to satisfy him and have sent the annexed reply to *The Engineer*, and think your readers will also take an interest in perusing our answer.

ARTHUR BOLLINCKX.

Brussels, Belgium.

TRIP GEAR ENGINES.

17TH MAY, 1895.

The Engineer:

"Colonial Engineer" makes a great mistake in taking the diagram only in consideration.

I have tested engines by slowing down the speed of the drop of the dash pots, and have thus obtained a diagram similar to the one obtained from a slide-valve engine, and without having a worse result as to consumption.

I ascribe this to the fact that what I lose in diagram surface I gain in superheating through wire-drawing the steam.

I prefer Corliss trip gear and other gears derived from the same system on account of the smaller effort the governor has to exert, thus giving a better regularity to my long admissions ($\frac{7}{10}$ of stroke).

But the increased steam consumption of slide-valve engines arises from the fact (I mean those engines that have not four slide valves) that both admission and discharge pass through the same conduits. The result is that the conduit is cooled down by the discharge, and the admitted steam is in a great proportion condensed, imparting a loss which is not shown on the diagram. The same happens with the slide valve which is alternately heated and cooled, and once more at the expense of steam consumption. With vertical engines, water remains on the piston and thereby increases their consumption beyond that of horizontal ones. Willans' engine is the only engine that has not this inconvenience by having its discharge directly above and in the center of the piston. He even has given it a concave shape so that the water floods towards its center through the piston rod, and this accounts for the good results arrived at.

Besides, slide-valve engines are not so easily lubricated as trip-gear engines, they have packings to maintain, and they wear out much quicker.

The slide valve covers several ports, and consequently the pressure per square inch of friction surface is enormous.

Anent the skill of salesmen, this is well supported by the numerous remarkable results which the engines they sell have obtained and continue to obtain. Salesmen of slide-valve engines would certainly increase in number and become more numerous than trip-gear engine salesmen if the slide-valve engines could show some tests, reliable and accurate, proving that they consume less than Corliss engines.

ARTHUR BOLLINCKX.

Concerning the double-beat drop valves, experience has proved that a Corliss valve can remain tight and work without any repair for 20 years, whilst double-beat valves require during the same period frequent surfacing to keep them tight, which has a very considerable importance for the steam consumption of an engine.

Lignum-vitæ for Bearings, Crosshead Gibs, Etc.

Editor American Machinist:

In your issue of May 30th a correspondent, writing with reference to crosshead gibs, gives some details as to the use of lignum-vitæ to increase their durability.

During my early days in the machine business I had some experience with the application of this wood for bearing purposes of different kinds, the result of which made such a lasting impression on my mind that I have often wondered why it is not more extensively employed for bearings than it is. I advocate its use whenever opportunity and the conditions of the case are favorable.

When applying lignum-vitæ for bearings subject to wear, it should always, if possible, be arranged so as to take the wear on the end of the grain. In this position, when efficiently lubricated and not subjected to excessive pressure, its resistance to wear is somewhat astonishing. When the wear is taken on the side of the wood, or with the

grain, it is less durable, and lubrication is more imperative. When run dry on the side of the grain a much softer material will wear it rapidly, as may have been observed in the case of a boy's wagon having wheels of lignum-vitæ and axles of some softer wood.

As a lubricant for lignum vitæ water appears to be as efficient as oil, especially when the bearing is on the end of the grain, but the supply of water should not be stinted.

One case with which I had experience was that of a double marine engine, of the inverted vertical type, having very short connecting rods, which caused much trouble with the crosshead gibs. The vessel seldom returned to Baltimore after a run to Charleston that the gibs did not require renewal or lining out. After several different materials had been tried with indifferent success, I induced the engineer to substitute lignum-vitæ. He expressed great doubt as to its success, chiefly on account of the limited thickness available for the wood. However, I recessed the pattern which had been used for the metal gibs, and managed to get a depth of about ⅝ inch, leaving a wall around the recess of about ¼ inch thick. The gibs being prepared, I fitted lignum vitæ into the recesses, with the end grain bearing on the guides. No necessity was found for fastening the wood to the gib castings, because when in their places in the engine the wall of metal around the recesses prevented the wood getting out. And I can testify that no further trouble was experienced with those gibs while I remained at the establishment where the vessel was repaired, which was several years after the lignum-vitæ had been applied.

I will quote another instance of the successful application of lignum-vitæ. It was that of the stern bearing of a tugboat. The custom with bearings of this kind was to fit strips of lignum-vitæ into the bearing with the grain running parallel to the shaft. In the case that I allude to I got permission to put it in with the grain running radially, which was readily done by cutting the wood into short pieces, and making them join neatly when fitted into the dovetail grooves. In fitting this bearing to the boat care was taken to so arrange it that it could be reversed when the lower part should be worn away. Meeting the owner of the boat several years afterward, after the boat had been in use and subject to the severe service that falls to the lot of a tugboat in a busy harbor, I inquired of him whether he had had occasion to reverse that stern bearing. He replied that he had not, and further said that he could scarcely notice any wear whatever in the lignum-vitæ.

The end bearing of a vertical shaft was another case of the application of lignum-vitæ with gratifying results. In this case the end of the shaft was arranged with a cup, into which the wood was fitted, its grain running lengthwise with the shaft. The shaft revolved on a hardened steel disk, which had a small hole in the center through which water was made to flow. No trouble was experienced with this bearing, but a great deal of dirt and annoyance was avoided by the substitution of water for oil as a lubricant.

Feeding the lubricant into the center of a bearing of this character appears to be the rational way of applying it, as it works from the center outwardly by the centrifugal action of the revolving shaft. When the lubricant is applied at the circumference, while the shaft is running at any great speed, it is almost impossible for the lubricant to penetrate to the center.

Washington, D. C. I. MCKIM CHASE.

The Proper Selection of Steel for Dies.

Editor American Machinist:

Steel intended for die work should be in all cases, when possible, ordered directly from the makers, giving them all the information possible as to the use it is to be put to, and the class of work it is intended to punch. It should also be annealed at the mill, as the extra cost is more than offset by the ease with which it is worked, and the certainty with which it can be hardened. Much of the trouble experienced with die steel could be avoided by this method, except that caused by improper heating by the smith in hardening.

Steel for dies should be free from seams and flaws, of even color, not too high in carbon (from .09 per cent. to 1 1 per cent. is a good proportion), and capable of being hardened without shrinking or changing its shape to any great extent; except in the case of drawing dies, when this fault is a desirable one as the die can be (when worn) reduced in size by being rehardened, thus increasing the amount of work the die will perform.

When you have once found a grade of steel that you know to be suited to your work, "stick to it," don't be induced by a smart agent, with a box of cigars, to give him an order, even if he claims (as one did to me not long ago, and which I was foolish enough to try) that he has a brand (price 35 cents) that will not shrink or change its shape in the least, and will stand any degree of heat without injury. If you find, as I think you will, that it is impossible to get any one grade that will fill the bill for all kinds of dies, mark each kind so you or your men can tell at a glance what kind of stock it is—a good way is to paint a stripe the whole length of the bar, and a different color for each make or brand of stock; the stripe going the whole length of the bar, you can tell the make, no matter how short the piece may be; as shellac is the paint most abundant with me, I use red, black, and white shellac, and use but three grades of stock.

I would like to insert, here, the makes of steel that have given me the best results, but for fear the editor will think I am getting in a free advertisement, I will only say that they can usually be found on the last pages of this paper.

For drop press dies for cold dropping, I like a steel that is a little high in carbon, and then give the die plenty of stock to avoid breakage.

For very large drop dies for tin or thin sheet-metal work, a die made of a steel casting and then case-hardened will give the best of satisfaction, the punch being left soft; for small cutting dies I take the steel in the bar and plane or grind it the whole length to the shape necessary to fit the die shoe, this makes the dies more uniform, and the die setter doesn't kick because the dies do not fit his shoes, and ask if we can't make two dies of the same width.

As far as possible, use steel of standard width; as 2 inches, 3 inches, 4 inches, 6 inches and 8 inches, and the dies the same, and this will avoid taking off any extra amount of stock more than is necessary to make the steel harden properly.

And now, one word about hardening; don't hurry the smith, don't give him a 6-inch die at 11.30 and ask him if he can't have it "right after dinner," and then blame him if it is fire-cracked, or the corners spawl off; give him good steel and plenty of time, and if he is any kind of a smith your die will come out all right; if not, why lay it to the steel, and tell the "boss" you don't think much of that steel, anyhow.

If you get a good piece of steel, I will try and tell you, the next time I see you, how to make a die of it. A. P. PRESS.

Gas versus Electricity.

BY WM. COX.

The success, although somewhat limited from a scientific point of view, when its ultimate possibilities are taken into consideration, which has so far attended the introduction and application of electricity as a means of illumination and for purposes of motive power, has greatly stimulated gas engineers and others, and the results which have in recent years attended their labors in certain directions augur well for the future.

Artificial or coal gas was first made practically useful as an illuminant by Robert Murdoch in 1798, when he partially lighted up by its means the famous workshop of Boulton & Watt, at Soho, near Birmingham. Its extension, owing to the many improvements effected in the process of manufacture, was rapid, so that in less than a quarter of a century it was almost universally adopted in large cities. For many years little was however done on new lines, the improvements effected having generally in view more economical production and a better light, the first of these objects being attained principally by the disposal of the various by-products or residuals, and more perfected appliances, while a purer quality of gas and improved burners largely influenced the latter.

It is within a comparatively recent period that uses for artificial gas other than for illumination have been sought for. In 1860 Lenoir introduced his gas engine, of which several hundred were sold in France, Germany and England during the following five years, but persistent attempts made to introduce it into this country met with no success whatever. A few years later appeared the Langen & Otto gas engine, which in spite of its defects was well received in Europe, factories being established in England, France, Germany and Austria, whose individual output was about 1,000 a year. Like its predecessor, it also failed to obtain a footing in this country, owing in a very great measure to the price of gas being here from $2 to $4, as against $1 on the other side of the Atlantic.

Further improvements led to the bringing out in 1876 of the Otto "Silent" engine, which immediately obtained great favor in England, and was finally, after overcoming much opposition, introduced in this country.

A few years later electricity appeared on the scene as a competitor with gas for illuminating purposes, first dazzling a wondering public with the intense brilliancy of the arc light, and later calling forth their admiration of the possibilities of the subdued effects of the incandescent lamp. Then came the wonderful adaptation of electricity to all kinds of power purposes, traction, hoisting, machine and tool driving, pumping, transmission of power, etc., all of which became stubborn facts for the gas men, thanks to the invention of the electric motor. They were now thoroughly aroused, and fear for the possible extinction of their lucrative industry filled the breasts of all interested therein. But competition is productive of good to the public. So in this case the fear of what might result from the introduction of this new illuminator and motive power led the gas manufacturers and engineers to bestir themselves, and not only to endeavor to give their customers greater satisfaction as far as the price and quality of the gas were concerned, but also to seek new fields for the utilization of their products.

Their attention was under such circumstances naturally drawn to the gas engine, and they with a number of machinists, realizing that the time had at length come when there might be some possibility of their making a commercial success of the new motor, devoted both time and energy to it, seeking to improve its construction, diminish its consumption of gas, and reduce its cost. The lead was taken in this new move by the Otto, of which over 40,000 have already been sold, varying from ½ to 120 horse-power. As an indication of the enormous progress made in the principles of construction, it may be mentioned that the Lenoir 35 years ago consumed from 90 to 105 cubic feet of gas per horse-power per hour, the Langen & Otto about 44, while the present Otto with several others are guaranteed not to consume more than 15 cubic feet, thus making this motor not only a convenient and safe one, but also an advantageous one as far as working expenses are concerned, and that despite its comparatively high first cost. Then came the Welsbach burner which with about 3 cubic feet of gas produces an immensely superior and brighter light than the common gas burner consuming 4 cubic feet. This lamp which is now largely used for lighting stores, halls, large dwellings and even streets, is increasing rapidly in public estimation and causing considerable uneasiness to many electric lighting companies.

A wide field remains, however, where gas is still unused here, and the gas manufacturer and engine builder would do well to consider it seriously, as there appears to be every prospect that a rich harvest could be derived from it. Up to the present time horse-power used for the traction of our street cars has been replaced by the cable and the trolley, each of which has developed great inconveniences, resulting unfortunately, in the case of the latter especially, in serious loss of life. This loss might undoubtedly in many cases be diminished by greater care on the part of the public, more stringent regulations as to speed, right of way, etc., but on the other hand it has also been frequently urged in extenuation that the cars so propelled were at times beyond control.

Numerous and continuous experiments have been made in Germany and England with street cars propelled by gas motors, the results of which have been found highly satisfactory. The gas is stored in three tanks under a pressure of 6 atmospheres, their combined capacity being about 33.5 cubic feet, or about 200 cubic feet at atmospheric pressure. The consumption of gas is about 18.8 cubic feet per car mile, so that the supply is ample for a continuous run of 10 miles, and as the refilling of the tanks occupies less than a minute, any delay on that account is inappreciable. The motors used are from 8 to 15 horse-power, while special ones of 20 horse-power are being at present constructed. The speed attained is 8 to 12 miles, and it is under perfect control, and may be reduced as found necessary. Other great merits put forth are that the car can be stopped when running at full speed within its own length, it starts without noise or shock, is free from heat and smell, and is safely handled in crowded thoroughfares. Such advantages ought to commend such a system to our long-suffering city populations.

The following figures have been published as the results of practical tests made at Dresden, where these cars have been running regularly for the last nine months, and giving every satisfaction.

Construction for a 5-mile double-track road, 20 cars, all wires, horses, motors and other equipments included:

By gas motor system	cost	$28,500	per	mile.	
" electrical	"	" 36,200	"	"	
" horse car	"	" 26,700	"	"	

The net operating expenses are:

By gas motor system	6.0	cents	per	mile.	
" electrical	"	8.0	"	"	"
" horse car	"	10.0	"	"	"

It is also stated that during the severe weather which was almost universal last winter, the gas-driven street railways in Germany maintained an uninterrupted service, whilst electric cars were frequently stalled on account of the snow, and the service was often subject to suspensions and cessations. Such results seem to point to the desirability of thorough and comprehensive trials being made of the system in this country, so that, if for no other reason, the competition may determine the trolley companies to observe greater care in the regulation of their traffic, and also adopt some other method of carrying the current in place of the present dangerous overhead network of electric wires.

The University of Wisconsin has recently conferred the honorary degree of LL. D. upon Mr. Edwin R. Reynolds, the well-known engineer of Milwaukee, and upon Mr. Don J. Whittemore, of Milwaukee, chief engineer of the Chicago, Milwaukee & St. Paul Railway. This distinction is undoubtedly well merited in both of these cases, and the University, as well as the gentlemen named, is honored by this action.

The Regents of the University of Wisconsin (at Madison) have arranged for nine engineering scholarships, which entitle the holders to the remission of their incidental fees for the period of two years. These will be thrown open to competition annually.

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A Feature of the Rise in Wages.

As our readers well know, the AMERICAN MACHINIST believes in high wages—believes they are a cause as well as an indication of good times, and that, within reasonable limits, highly paid labor, properly employed and managed, produces the lowest cost goods.

Believing this, we are, of course, very glad to witness the recent upward movement in the rate of wages, and hope it will continue; our belief being that it will benefit, not only those who receive, but those who pay wages as well.

But this does not mean that a manufacturer engaged in a line of work in which he meets active competition, can continue to pay materially higher wages than his competitors pay for services of the same quality. That is to say, his work must not under such conditions cost him much, if any, more to produce than similar work costs his competitors; and right here is a feature of the present situation which is not as clearly understood in some quarters as it should be.

When the decline in wages took place, following the panic of 1893, some manufacturers took every possible advantage of the fact that many men were out of employment, and reduced wages almost, if not quite, to the "living wage" of the political economists—20, and even as much as 30 per cent. reduction having been made in some cases. Other employers, on the contrary, resisted the downward tendency of wages, kept the rates as high as possible, and in many instances made no reduction at all.

Now that the upward movement has begun, it is naturally those establishments in which the greatest reductions were made that feel first and strongest the necessity for advancing wages in order to keep their best men, and in some instances the advances of, say, 10 per cent., which only partially compensate for previous reductions in the same shops, are being taken as evidence that wages should advance also in other shops in which little or no reduction took place. It is quite plain that a shop which has now advanced wages 10 per cent. as a partial compensation for a previous cut of 25 per cent. will have a very great advantage over a shop similarly situated which has made no advance, but which reduced only 10 per cent., or not at all, while reductions were going on.

Reasonable men will not hesitate to look these facts squarely in the face, and be governed accordingly; but in the meantime we hope conditions will be such that those employers who wish to advance wages can do so, and that the others who are below the general level will have to follow suit or be content with cheaper and really more expensive labor.

We believe that while there are exceptions, yet most manufacturers recognize the fact that good business conditions are dependent largely upon well-paid labor and are willing to be fair in this matter, but they must be fair to themselves also, or go out of business, where their business meets with any sort of competition worthy of the name.

The Tool and the Tool Holder for the Vertical Shaper.

When we attempt to say a good word for the slotting machine, and show how it gives such a good opportunity for the operator to see all the while what he is doing, we are likely to be met at once by the objection that the operator of the modern machine must be able not only to see what he is doing, but he or the machine must also do it, meaning, of course, that it must be done with sufficient rapidity and precision. This really hits the secret of the decadence or the desuetude of the slotting machine. It is because it has continued to be a slotting machine and that only. The long, slim, springy tool, except where its employment is absolutely necessary for the individual job, is not the thing for anyone to employ who means business. "The nation that shortens its weapons lengthens its boundaries." And so the slotting machine must extend its domain by abandoning the slotting idea for general work and by abandoning the suggestion of slotting in the existing form of the tool holder. The steel of which the cutting tool is made should be held at right angles to the slide instead of parallel with it. The machine should become so completely a shaper that the tools of the common shaper should be interchangeable or identical with those employed by it. For working all around a piece, or for any outside work, the vertical shaper has the advantage of the horizontal machine in that it has no special preference as to the direction in which the tool shall face or do its cutting. The horizontal shaper has the work to be cut usually below the tool or at slight angles from the horizontal. To the vertical shaper this is or may be a matter of indifference. It will cut before or behind, or on either side, or at any angle of the circle, and, as the work may be and usually is also upon a turntable, that also may be turned to the position most convenient for working. The tool in the horizontal shaper, like the planer tool, is able to lift and clear itself during the return stroke, and this important feature can also be easily provided for the vertical shaper, and this clearance may then be made to operate in any direction by having the base of the tool holder and the swinging joint revolvable. The tool would not right itself for the cut by the action of gravity, but a light spring might be provided that would be equally effective for the purpose. The slotting machine evidently needs to have a suitable tool-holding device provided for it for general use, and a resolute insistance upon the name for it of vertical shaper to widely extend its usefulness. If we make it more useful it will get more work. It works the same way with men also.

Peculiar Boiler Material.

The valuable article upon "Boiler Explosions," which we have condensed and reproduced, was supplemented by quite an extended discussion, in which quite a number participated, including, by correspondence, Dr. C. E. Emery, of New York, and Mr. B. F. Isherwood, Chief Engineer U. S. Navy. The following statement of Mr. Isherwood is so remarkable that it seems to deserve reproduction:

In an important explosion experiment made many years ago at Sandy Hook, on a large boiler with a rectangular internally-fired shell, by Mr. F. B. Stevens, of Hoboken, the metal of several seams, after a terrific explosion which entirely destroyed the boiler, had been found to be in as good a condition as before the explosion. The rivets and rivet holes had been intact and quite uninjured, and no metal forming part of the seam had been ruptured. The two plates united by the seam had been, however, entirely separated, some of the rivets sticking into one plate and some into the other, although the rivet heads had not even been bruised, and the rivets not even bent. The metal of the plates at the seam had stretched so much under the stress, without rupture, that the rivet heads had slipped uninjured through the rivet holes, which had been sufficiently enlarged by the stretching to pass the rivet heads, the holes recovering their normal diameter by the elasticity of the metal as soon as the stress ceased.

The Foreman's Legs in Long Shops.

We expect one of these days to find a certain firm boasting, in their voluminous catalogs and elsewhere, that they have the longest shop ever built. When that event occurs their supremacy in longitudinal dimensions will be due simply to the fact that other firms have not been so foolish in their building. Length beyond reasonable limits is anything but a desirable thing for a shop. It is difficult to find any plausible excuse for it, except in the simplicity of design and construction, and simplicity is a good thing. The distribution of power, and still more, that of material, is increased in cost by this simplicity. It is doubtful if even better light is secured by it. Skylight may not be always the best in the world, but it is vastly better than second-hand skylight, and we generally have to content ourselves with one or the other.

But we were rather thinking just now, not of the shop, but of the tools, and especially of the tools indicated by our title. They are among the most indispensable things in the equipment of the shop, and they probably receive less thought and consideration than even the grindstone. Some proprietors have a tolerably clear idea of the duties of a foreman, many of them have very exacting ideas upon the subject, and we are not disposed to quarrel with them upon that topic; but very few have given much thought to the physical labor involved in the faithful fulfillment of the foreman's responsibilities. It is useless to attempt an enumeration of a foreman's duties, as they are so multifarious. A foreman must know what is to be done, how it is to be done, and when it is to be done, who is to do it, and what tools are to be used. He must see that the work is so distributed that, as far as possible, every man will be employed at his best, every tool will have the work best adapted to it, and no tool will be assigned more than it will be able to accomplish. He must see that all material is ordered and coming along when needed, he must know that it is all right when it comes, and have it distributed as required, or readily accessible. Then there is the keeping up of repairs and the maintenance of everything in good working order, including the men, and, after all, this can be called only the preliminary duties of the foreman. After everything is started in good order it needs his constant supervision, and there is in some shops scarcely a minute when he is not wanted, or at least needed, in one place or another, or in places far distant in rapid succession, so that many a foreman is kept upon a constant jog-trot from morning until night. There are unpretending foremen in some shops that do almost as much traveling every day as a letter carrier, which would not be so bad, only that their other duties in addition to their pedestrianism are rather more onerous and responsible than those of Uncle Sam's messengers. We do not advocate the bicycle for the use of the foreman in any shop, and we would regret to see one so mounted. It may not be in all respects a bad thing to have a dominating or central idea in the design of a large shop, but it may after all be better to build the shop around the foreman's legs than around the traveling crane.

A Needed Addition to the Radial Drill.

There is one feature of our radial drills that we think is open to serious objection, and the only reason it is not strongly objected to by users is that they are so much accustomed to it that it is regarded as a regular and necessary feature of the machine. We refer to the means, or rather to the lack of means, for swinging the arm about the column. At present this must be done by what has sometimes been called Kentucky science, *i. e.*, main strength and awkwardness. When the point of the drill requires to be moved a sixty-fourth of an inch to or from the column it is accomplished by turning a hand wheel which moves the saddle easily and accurately upon the arm, but when the drill must be moved in any other direction to adjust it to a precise position a weight from five to ten times as great must be moved without any hand wheel—simply by pushing or pulling directly upon the arm; and we all know the difficulty of making a fine or close adjustment of any kind when the movement must be effected by such a method.

Some years ago we illustrated and described an English radial drill, in which this defect was overcome by placing at the column a segment of a gear with which a pinion engaged, said pinion being turned by worm gearing and a hand wheel. Thus by turning either of two wheels placed closely together the drill could be easily and precisely moved in any desired direction until accurately located. It seems to us that this feature

adds very much to the facility of handling a radial drill; it does not cost much and could be easily applied in most cases, whether the column turns with the arm or the arm turns upon the column.

We note with pleasure that our esteemed contributor Mr. William Kent is now a member of the editorial staff of the *Engineering News*, and is to have special charge of matters pertaining to mechanical and metallurgical engineering. Under his trained and able guidance we may confidently expect to see this department of our valued contemporary raised to a still higher plane of excellence and interest.

Literary Notes.

CASSIER'S MAGAZINE.

The July issue of *Cassier's Magazine* comes to us in such a bulky form as to suggest the propriety of issuing the monthly number in two volumes. The number is devoted entirely to the Niagara Power Installation. The magazine proper numbers 222 pages made up as follows: Blank pages, 11; full page half tones, 51; other half tones, 38 pages; full-page drawings, 14; other drawings, about 14 pages; text, about 94 pages. Evidently in the evolution of the modern magazine it is only a question of time when the text will disappear. The matter in the present issue is written by able men, each writing upon the topic with which he is presumably most familiar and in which all the writers are interested. Some of the illustrations illustrate, most of them are good, and they number nearly two hundred.

We have received an annual report of the Pennsylvania State College for the year 1894. This report shows the college to be in a very prosperous condition, with a steady increase of students for several years past; against 92 students in 1883 there are now 317; the teaching force has been increased from 17 to 40; the number of counties represented from 22 to 50; and the increase in the college classes amounts to nearly 500 per cent.

Originally an exclusively agricultural education was given in this college, but now it has added several other courses of study, including mechanical engineering, electrical engineering and mining engineering. The students receive also a practical training in carpentry, machine building, etc., in shops well equipped for the purpose. The military department is in charge of an officer of the regular army, detailed by the War Department, as Professor of Military Science and Tactics.

Worse than Trolley Car or Steam Boiler.

At Lawrence, Mass., Bridget Collins had her right hand caught in the machinery, and a forefinger was badly lacerated.

At Willimantic, Conn., Mary J. Connell caught her foot in the machinery, rupturing the ligaments and cracking a bone of the ankle.

Manuel Denvers, at Fall River, Mass., slipped off a belt, and his hand was drawn into the stripper and cut off at the wrist.

A little girl in the Atlantic Mills, Olneyville, R. I., had a hand caught in a spinning machine. The forefinger was broken and badly lacerated.

George Telham, Cohoes, N. Y., was caught by the hand in a card and the flesh was torn from the finger ends to the elbow, laying bare the muscles.

A boy, 14 years old, at Andover, Mass., had his hand caught in the machinery and badly jammed, and lost a finger.

Esther Firth, at Lawrence, Mass., had her hand caught in the machinery and was severely injured.

Joseph Edmunds, Lewiston, Maine, lost his arm in a finishing picker. Only for the fact that his arm was completely severed, his whole body would have been drawn in.

A young man in the Kavanagh Knitting-mill, Waterford, N. Y., was caught by his clothing when putting on a belt and badly lacerated and bruised.

The above occurring in one week in the textile establishments of the Eastern States suggests a rather lamentable state of affairs.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(281) H. P., Ocala, Fla., writes: Please give me an idea of the process of blue printing. *A.*—See answer to Question 120, in our issue of March 8, 1894.

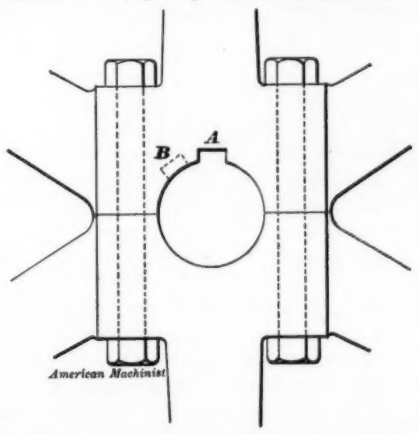
(282) C. W., New York, writes: I would like to be informed where an application should be made for a position as machinist in the U. S. Navy. *A.*—Apply to the engineer-in-chief of the Brooklyn Navy Yard.

(283) A. M., ——, asks: Where can I obtain a copy of the "Walker Gear Scale?" *A.*—You can ascertain by addressing its author, John Walker, M. E., who is general manager of Fraser & Chalmers' works, Union and Fulton streets, Chicago.

(284) H. B. M., Michigan City, Ind., asks: Can aluminum be substituted for copper and steel in making an electro-magnet? *A.*—No. 2. How much more does aluminum cost than copper? *A.*—That depends on the quality of both metals and the quantity bought. Copper can at present be had from 10¼ to 11 cents per pound, and aluminum from 50 to 63 cents per pound in small lots. 3. What method is there for tempering aluminum? *A.*—By hammering, rolling or drawing aluminum becomes sensibly harder and stiffer, also by long gradual cooling the same result is obtained; in this way its temper can be made equal to that of a watch spring.

(285) E. E. P., Jeffersonville, Ohio, asks: Could a modern steam derrick raise the largest stones used by the ancients in their buildings? *A.*—We do not know, because the weight of the largest stones used by the ancients is not known. 2. Can an ordinary draft horse develop one horse-power for a short time by exerting its utmost strength, and hitched to the load in the ordinary way? *A.*—It may, but we should not expect it. See answer to Question 249, in our issue of June 13th, current volume. 3. Does a ball from the best rifle have as much force as a stone thrown from a sling in the hands of an expert slinger? *A.*—The ball will have the greater force. 4. Please give the tensile strength of the best steel. *A.*—We should not allow a greater ultimate tensile strength than 100,000 pounds per square inch. For important structures, or for a special brand of steel, we should get the strength from the manufacturer of the steel.

(286) X. Y., ——, Italy, asks: Where should the key be placed in the hub of a split pulley, or fly wheel? I have never seen anything in regard to this matter published in your columns. *A.*—Everything considered we should place the key at *A* as shown in the accompanying illustration. The advantage of this position of the key is that this half of the pulley can be taken off more



readily, when necessary, than when the key is placed in any other position. In fitting the key care should be taken that it does not bear against top of the keyway, otherwise there is danger of subjecting the bolts to an excessive stress. If there is danger of the key bearing against the top it may be better to place the key at *B*; this will lessen the tensile stress in the bolts, but the disadvantage of this is that the upper half of the pulley as shown here cannot be taken off without taking out the key which in some cases may be very troublesome if not impossible to do.

(287) C. W. F., Port Richmond, Va., writes: Please favor me with a description and size of a tool chest for a machinist; also state if it should have a drawer or two. *A.*—The general design of a machinist's tool chest depends largely on the nature of the work a machinist is engaged in, which determines the size and kind of tools to be kept. A tool chest too small will cause a continual disappointment, and a tool chest built on the principle as people built houses, too large for the present, but just right for future accessions, may become a regular nuisance. Consequently first decide on the kind of tools you wish to keep in the chest, from which the size may be determined, and then adopt such an arrangement of drawers, tills, etc., which will give an easy access to all tools, particularly to those which are used more frequently than others. A tool chest of the following size has given good satisfaction: Length outside, 18 inches; width, 11 inches; depth, 11 inches; strengthening strips ½ inch thick should be fastened around the top and bottom of the box; this will increase the outside dimensions to 19x12x11 inches. Make the lid 1 inch deep inside; this will form a good receptacle for large squares, straight-edges, etc.; these should be held in position by suitable strips nailed to the cover. A shallow till, 1¼ inches deep and 4½ inches wide, arranged to slide in the upper part of the chest, will be found convenient for those tools which are not so frequently in use. The body of the chest, upper part, may be used for the larger tools, such as hammers, monkey wrenches, etc. Three drawers in the lower portion of the chest will be found convenient for the smaller and finer tools. The drawer next to the bottom may be made to extend throughout the whole length and breadth of the chest, and two drawers may be placed directly above it, each one occupying a little less than half the length of the chest; the depth of all these drawers should be about 2 inches outside measurement. You will find illustrations of different designs of tool chests in our issues of May 7, 14, 28, June 11, and July 2, 1891.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 572.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

Air compressors for all purposes and pressures. Clayton Air Compressor Wks, 28 Cortlandt St., N.Y.

Foster Engineering Co, Newark, N. J., Pressure Regulators, Reducing Valves, Pump Governors.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

Wanted—I wish to correspond with parties who wish to engage in the manufacture of chucks, as illustrated in this issue of the AMERICAN MACHINIST. Address Ross M. Russell, Binghamton, N. Y.

Machine work solicited; complete equipment modern machine tools; patternmaking, designing, experimental work; tech. assistance if required; best facilities & very reasonable prices. P. Pryibil, 512-524 West 41st St., N. Y. See page 576.

Just Published—"The Modern Machinist," by John T. Usher. Price, $2.50. Each of its 257 illustrations represents a new device in machine shop practice; a new book from cover to cover; agents wanted in every machine shop; send for special illustrated circular, Norman W. Henley & Co., 132 Nassau street, New York.

The Story of a Great Invention—The Appleby Twine Binder.

This is the story of an invention which cheapens the cost of every bushel of wheat harvested, and of every loaf of bread made, and which, measured by benefits conferred upon the human race, ranks with the work of Watt and Morse and Fulton.

The idea was simple, only the thought that a reaping machine might have added to its means of cutting standing grain and delivering it in bunches of loose stalks, ready to be gathered and bound with a band of its own substance into a close bundle by five or six men who followed in the path of the machine, such mechanism as would enable the machine itself to tie a stout cord about each bunch of grain stalks as it formed them, and so save the labor of the five men whose toil was needed to tie the bundles with grain bands.

The idea was as simple as Watt's idea of the separating of the condenser from the cylinder of a steam engine; Morse's even simpler idea, that the magnet-attracted bar might mark a paper and transmit thought instantly through any terrestrial distance; or Fulton's still more simple and seemingly obvious deduction, that the steam engine, which was well known to have the power of turning great wheels on land, could be made to turn the paddle wheels of a steamboat on water.

A fortunate ending has come to the thought of Appleby, who, as a youth of eighteen, invented the simple, once-revolving pair of jaws, which now make the knot that secures every bundle of grain cut by automatic reaping and binding machines the world over; but between Appleby's thought that the reaper could tie up its own bundles of grain, and his almost immediate production of what has proved to be the only satisfactory twine knotter for binding grain, and the production of a machine which would surely bind its own bundles of cut grain in the harvest field, lay a great waste of stormy desert years, which Appleby crossed in poverty and disrepute; sustained only by his own fixed conviction that his thought was true, and so must succeed at last. Time and toil proved him right, and the day came when Appleby, the crazy inventor who thought reaping machines could be made binding machines as well, was able to look calmly down on his detractors, and abundantly reward the few friends who had aided him in his long and weary battle against circumstance and prejudice.

And it seems strange indeed that prejudice, a mere whim of contrary belief, an absurd misunderstanding of plainly evident conditions, can so delay the successful use of things most needed by the world at large. Long after Watt had proved the entire soundness of his ideas in regard to the steam engine, he writes his intimate friend that he has buried the engine which has impoverished his friends and taken the best years of his life for naught, and that he hopes it may sleep in quiet, while he turns his attention to work which will at least give him a living; Morse, with a working wire, was the laughing stock of our wise legislators at Washington, and the learned Dr. Lardner proved by conclusive mathematics that no steamboat could ever carry fuel enough for long voyages, even while the first transatlantic voyage by steam was actually being made.

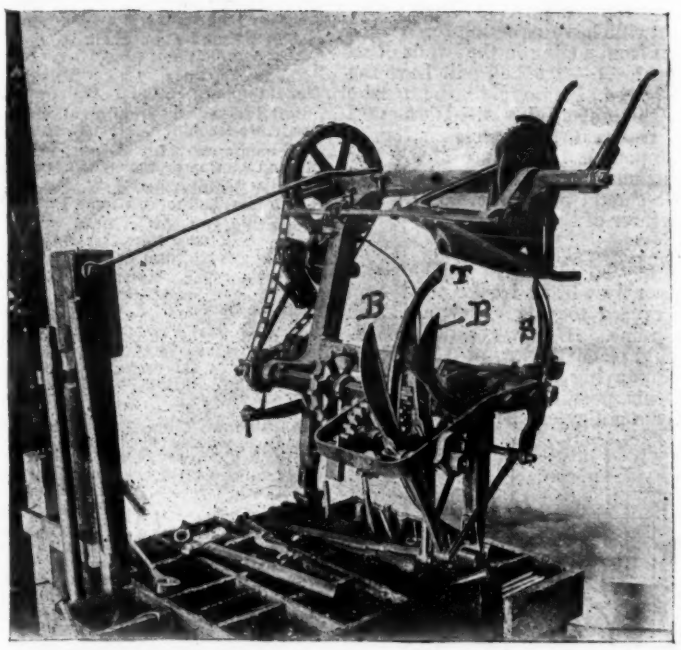
So Bell, the Hartford school teacher, who thought the human voice could be heard for hundreds of miles, showed at Allyn Hall his telephone connected with Farmington, 16 miles away, and at this public gathering of his townsmen wanted to sell half his invention for five thousand dollars, and the astute Yankees buttoned their pockets up tight, and looked wise as they told each other it was a curious kind of a plaything. Whimsically enough, after Appleby could really tie a bundle in the field with certainty his invention was kept out of use for several additional years by the absurd assumption that the crickets would eat the strings off the bundles before they could be threshed, and so the use of the twisted wire grain binder was continued, in spite of the entire unsuitableness, and grave accidents to flouring mills, directly traceable to the use of wire for binding grain.

The myth of the voracious crickets was enough to keep the twine binder out of use for a long time after Appleby had it in really practicable form, and the clamor against twine binding was so great that Appleby himself went into wire binders, and was busy over them for years, entirely against his own convictions as to what was best. In speaking of this he said in effect that he thought he could not be right when all the rest of the world was against him, and so followed the advice of others as to the direction of his efforts, though feeling he was wrong in so doing. The first successful reaper and binder did not use Appleby's inventions; it was brought out by Walter A. Wood, in 1873, and used the highly ingenious wire binder invented by Sylvanus D. Locke, of Hoosic Falls, N. Y. After the twine binder decisively displaced the wire

binder Locke left the East, came to Illinois, and established a factory for the production of a twine-binding machine which for some cause never came into large use, and is now out of manufacture. Thus to Locke belongs the credit of the first machine in general use as a self-binding reaper, though Appleby's binder was perfected years before Wood's automatic wire binders were brought out, and Appleby was neglecting his own twine binder and working on wire binders at the time when the inherent faults of wire as a grain band, were making the universal adoption of the twine band inevitable, and Locke, who made a success of wire binding, did not produce a satisfactory twine binder. Indeed, as previously mentioned, the knotting device invented by Appleby in his eighteenth year has never been equaled by any other of the vast number of different grain band knotters since brought out, and is to-day the one and only accepted mechanism for the service.

John F. Appleby was born in the town of Westmoreland, Oneida County, N. Y., in 1840, and in 1842 his father, a farmer of small means, emigrated to the then far west of Wisconsin, and preempted a small claim of 40 acres in the township of Lagrange, in Walworth County. The elder Appleby soon died, leaving his widow and children in such circumstances that the boy, John, had to take care of himself as soon as he was old enough to do anything at all; and at 17 was a farm hand in the employ of Solomon Hatch, in Iowa County, Wisconsin. Farmer Hatch, a young man who had just inherited his father's farm, bought a new reaper made by Falvey & Reiley, of Racine, and the farmer and the boy, John, were following this reaper around the field watching its operation. "Mr. Hatch said to me," said Mr. Appleby, "it works pretty well, don't it, Johnny?" I said "yes.". After following it a little longer, Mr. Hatch said: "Well, that's a perfect machine, ain't it?" I said: "No, it isn't a perfect machine—it ought to bind the bundles." Mr. Hatch said that could never be done; that a self-binder could never be made to work. I told him that it could be done, and I was going to make a self-binding reaper myself. When I said that Mr. Hatch turned round and looked at me and said, "Why, you little fool, you can't build a binder." I told him I thought I could, and I would show him some day. That summer day in 1857 was the first time the idea had ever occurred to me that a reaper could bind its own bundles. I never forgot what he said to me and what I said to him. I did show him, as it afterward happened, as I said I would, that I could build a self-binder, but it was a great many years after that, and there were a great many times in those years when it seemed likely that Mr. Hatch's words to me came a good deal nearer the truth than my words to him did.

The boy, John, had all that resolution and energy and doggedness of purpose, which are shown in the portrait printed herewith. With his jackknife and the few tools to be found in every farm house, John at once began the construction of his twine binder, the thought of which has never left his mind for an hour in all his life since. He went to school that winter, but all of his spare time he worked on his model of the self-binder, and he had from the very first a clear idea of the successful elements needed. The model John made the best way he could, mostly of wood, whittled out; the gearing he cast in sand, of pewter; and so, in one way and another, such as come by instinct to ingenious boys, he got his machine together, only to find that the imperfections of his material and workmanship kept it from doing what he expected. The demand for better mechanism was imperative; John had no money with which to pay for skilled labor; a capitalist was necessary. By the time young Appleby had brought his self-binding reaper to this stage of first failure in the normal course of the development of an invention, he had changed his employer, and was working for Mr. Houghton, another farmer, for $10 a month. Mr. Houghton had a younger brother, a thrifty schoolmaster, who had saved $500 in cash, and who listened to the inventive farm-hand's talk of the grain binder with interest, and became Appleby's first financial backer. For a skilled mechanic to do what Appleby could not do on the farm, there was a good gunsmith, one Price by name, at the little village of Palmyra, close at hand, and with this combination of Houghton, the schoolmaster, for backer; Price, the gunsmith, for constructor, and Appleby, the farm laborer, for mechanical engineer, the first, and, as it seemed then to those interested the most difficult, mechanical need of the new self-binder was satisfied by the production of a "knotter" which would surely tie the knot in the binding cord. Appleby worked on the farm daytimes and whittled out wooden patterns at night; these patterns the schoolmaster carried to the shop of the gunsmith, who duplicated them in metal with commendable skill and fidelity, resulting in the production of the actual



Mr. Appleby and His Binder.

"knotter" essentially the same as is in use to-day on all twine-binding reapers made. This original working knotter-model, made by Price, now living at Whitewater, Wis., is still in possession of Mr. Appleby, and is a good, well-shaped, well-finished piece of work, and is in all essential particulars the knotter since hundreds of thousands of times duplicated and now found in use on all self-binding reaping machines.

This knotter was finished in the month of May, 1858, when John Appleby was just 18 years of age. This successful and never displaced knotter was not the first one designed by Appleby; he made several of different designs, to tie different knots, before this final effort; none were so simple as the last, no other was so good in action, and no other tied so satisfactory a knot.

Appleby and Houghton thought that the production of the perfect cord knotter would end their experiments; they supposed they had only to attach it to a reaper they had ready, to triumphantly demonstrate the entire practicability of Appleby's self-binder.

Their first attempt at an actual trial showed a host of difficulties remaining; these difficulties were not easily met; young Houghton foresaw continued expenses, and after paying out something less than $50 cash to Price, the gunsmith, withdrew from his financial position, and thus became the first of a long line to abandon the money-backing of the Appleby twine binder.

Really the tying of the knot in the twine band is not the difficult thing in automatic grain binding; the other twine handling details of holding the free end of the twine, after the cut is made which separates the twine band of the last bound bundle from the ball, and bunching the bundle from the cut grain delivered on the binding table, are details difficult to produce, especially the bunching of the bundle to size. The standing grain may have very little straw, or it may have a rank growth of straw, so that in one case the cut grain might make a bundle of a certain size for every 10 or 15 feet of reaping machine travel, while in the other case twice that distance of travel would be needed to make a bundle of convenient size for handling. Consequently it is needful to make the size of the bundle determine the time of the binding.

This is effected by the use of the beaters *B B*, Fig. 3, which work one on each side of the eye-pointed twine-carrying arm *T*, called the needle. The beaters are crank driven, and have a forward and back and rise and fall motion, like the feed piece of a sewing machine, and so pass up through the grain stalks as they are delivered on the binding table, advancing as they rise, and moving towards the hinged spring bundle abutment *S*; one of the beaters, *B*, moving towards *S*, while the other, with its free end below the binding table, is moving back away from *S*. These simple crank-driven beaters are the invention of Appleby, and are the only device in use for bunching and sizing the bundle, though others have been tried both by Appleby and by other inventors of grain binders. The operation of the beaters, *B*, is to alternately press an added portion of straw into the bundle pushed up against the stop or abutment *S*, which is spring hinged, one beater holding the partly filled bundle against *S*, while the other drops down below the binding table, and goes back under the cut grain, and then rises up through the coming stalks, and so pushes another increment of the bundle in process of formation into the bunch against the abutment *S*, so that finally, when the bundle reaches the desired size, the advance of the beater forces the abutment to swing outward against the resistance of the abutment spring, and so start the previously idle binding mechanism proper into action, and thus cause the full size bunch of grain stalks to be bound into a bundle of predetermined size.

It should be noted that Fig. 3 is not a view of the Appleby binder in working position on the reaper. It is from a photograph of the binder action as it stands on the assembling bench in the shop; when in place on the machine the binding table covers so much of it that no intelligible picture could be made. In addition to the spring abutment, and the beaters, and the eye-pointed twine-carrying arm, and the once-revolving knotter, there is an automatic knife which cuts the twine as soon as the knot is made, and a pair of ejector arms, which toss the bundle off the grain table as soon as it is bound. Parts of the binder must stand still while other parts are at work. The whole must be very simple, infallible in the action of each part, very cheap in construction, and so designed as to be unaffected by dust and the accidents due to variations in the quantity and quality of material to be acted upon. Altogether perhaps no problem ever offered to the inventor combines more variations or affords a severer test of inventive ability; and, simple as the few rough parts of the Appleby binder are, as shown in Fig. 3, the experienced observer can easily understand why years of the most discouraging toil were required to perfect this seemingly insignificant piece of mechanism.

The young schoolmaster, Houghton, abandoned the twine binder in 1858; of course his want of faith did not in the least influence Appleby's belief. Had Mr. Appleby's confidence needed support from the outside, this story of the grain binder would mention his name only as one of those who failed. But Appleby was without resources, except the work of his own hands, and the thoughts of his own brain; working as a farm hand, he went to Kansas, was there in the memorable year of 1861, went among the first volunteers of the Union army to the front, and his attention was forcibly directed to the arts of war. While lying before Vicksburg he invented a repeating rifle, upon which he procured his first patent, afterward sold for $500 to Thos. W. Lane, of Boston, who in turn sold one-half of the patent to Valentine Fogarty for $7,000. While in the army Appleby employed his jackknife and his mind on the binder, but without accomplishing decisive results. He was mustered out of the service July 4, 1865, and went directly back to Iowa County, Wisconsin, carrying about $500 in cash, which he immediately proceeded to sink in experiments on grain binders. With this $500, a full-sized machine was built at the shops of Edward P. Allis, in Milwaukee, in 1868, and a Mr. Thompson, a miller, grain buyer, and rural capitalist with about $8,000 at his command, undertook to back the Appleby binder.

There were at this time grave doubts as to the suitability of twine for binding grain; no grain binder had yet been made a practical success. Many minds were laboring on the problem, and the general opinion was in favor of wire rather than twine binding as

the more likely to be finally adopted; some inventors were also endeavoring to bind with a band formed of the grain itself, as is done in hand binding. Thompson favored wire binding, and, although Appleby in his own mind never approved of the use of wire, he respected the choice of his backer, and all of his work with Thompson was done on wire binders. Various machines were produced, Appleby doing most of the work with his own hands, but all were faulty; all would work in some degree, but none were entirely satisfactory. The wire binder proceeded to a patent, however, the first of Appleby's on grain binding machines, taken out in 1869, eleven years after he first began to work on binding devices.

In 1870 Mr. Thompson, having spent about $5,000 of his small capital, and having become familiar with the state of the art as it existed at that time, concluded that Appleby's ideas were faulty, and that he, Thompson, could himself carry the matter to a successful conclusion; he therefore cut loose from Appleby in 1870, and went on by himself, leaving Appleby alone, impoverished and discredited, with only his faith, his hands and his head as resources. Thompson exhausted the remainder of his money without a fortunate result and abandoned the task. Appleby, still full of that faith which moves mountains, interested Dr. E. D. Bishop, of Mazomanie, Wis., and with Bishop for backer Appleby finally brought the wire binder into a satisfactory working condition, so that in 1872 he was able to show a wire binder that had worked successfully for two seasons in the harvest field, and with this practical result to aid him, he secured the assistance of Parker & Stone, of the Parker & Stone Reaper Works, Beloit, Wis. This was the first connection of any manufacturer with the Appleby inventions.

Upon the advent of Parker & Stone, Dr. Bishop dropped active participation in binder events, though he still held a verbal agreement which Appleby fully and generously kept when his day finally came, although there was not a line of writing to hold the contract. Nor was there even a written agreement with Parker & Stone, although Appleby's connection with them ran over a number of years, and up to the time when the value of Appleby's inventions was fully established, and a considerable part of them were covered by patents, all issued directly to Appleby, with no interest assigned to anyone. Appleby's first work with Parker & Stone was done on March 3, 1872, the year before Walter A. Wood brought out the first of Locke's successful wire binders. In 1872 Appleby had a wire binder produced by aid of Dr. Bishop's money, which had worked pretty well for two seasons, and this machine he at once proceeded to perfect under Parker & Stone, so that in the harvest of 1872 Parker & Stone and Appleby took the self-binding reaper to the harvest field of Mr. Dayton, near Beloit, early one morning, and cut and bound grain all the forenoon, the machine working perfectly. The end of that half-day's work was the one moment of triumph for Appleby. His machine did cut and bind grain in the harvest field; it was not a twine binder; it was a wire binder; but it did the work; it was the culmination of 14 years of hard work and bitter disappointment—but it worked, and worked to perfection.

As Farmer Dayton, Manufacturers Parker & Stone, and Inventor Appleby were riding in from the field at the end of that half-day's work, Mr. Parker proposed to Mr. Dayton that the machine should be put into his grain again that afternoon. "No," said Mr. Dayton; "I do not see what is to become of that wire band. It is going into the stack with the bundle; it may go into the threshing machine and make trouble there; it may hurt my cattle when they feed on the straw. It will not rot or burn; I don't want it on my farm, and I would rather you cut grain for somebody else this afternoon."

Parker & Stone saw the force of these remarks by Mr. Dayton; as they drove into Beloit from the farm they talked the matter over with Appleby; they could not see the way to build a machine farmers would not buy; they had spent between $2,000 and $3,000 on the self-binder, money enough to throw away, and they decided to stop, then and there. Appleby told them he could build a twine binder, but Parker & Stone thought they had put out money enough, and Appleby's hour of triumph was ended and done almost as soon as it began. Appleby was without means; he had $3.50 a day from Parker & Stone, and a family to support; he continued in their employ, bringing out a new self-rake and various other improvements, besides two fairly good twine binders. Appleby seems to have kept up some sort of connection with Parker & Stone, and at the same time to have made some business ventures on his own account. Undoubtedly he felt the delay in the pushing of the twine binder with a sharpness of disappointment which only those who have been in a similar position can comprehend; he bought into the Webber Fanning mill shop in Rockton, four miles from Beloit, in 1873. He started the Appleby Reaper Company at Mazomanie in 1873-4, and in the winter of 1874 he built a twine binder at the shops of Parker & Stone. The wire binder of Walter A. Wood, invented by Locke, had a success in 1873, which probably encouraged Parker & Stone to go on with self-binders; the Mazomanie concern did not prosper, and in 1875 Appleby built another twine binder for Parker & Stone, and went into the field with it, and it worked well. Still the wire binder was the success, and Wood was in the van. In 1876 Appleby built four machines for Parker & Stone, who then thought so well of the twine binder that patents were applied for. In 1877 Appleby built 115 reaping machines for Parker & Stone, twine binders, and these were the first twine-binding reapers ever put on the market. These machines worked well, were durable and good, and this year of 1877 marks the first real practical business success of the Appleby twine binder—19 years after the boast of the lad John to Farmer Hatch that he would show him, some day, that a self binding reaper was possible.

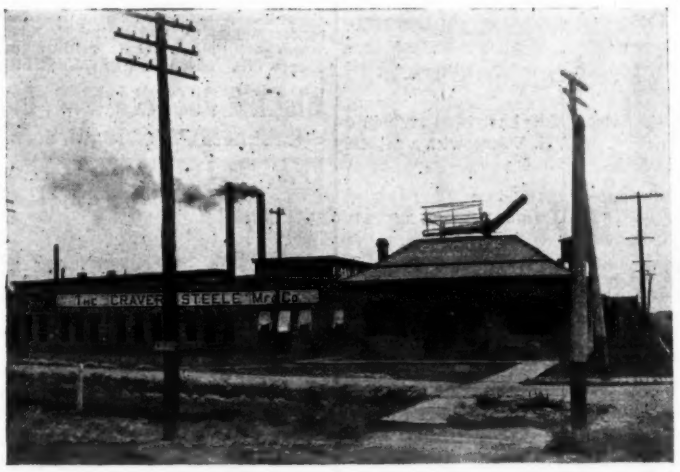
Of those connected with the invention up to this year of 1877, Houghton, who put the first $40 or $50 into the work of gunsmith Price before he withdrew, had entered the army, lost an arm in service, and died after the close of the war, somewhere in Michigan. Thompson had exhausted his money partly with Appleby, and partly on his own inventions, and had dropped out of sight. Dr. Bishop had used what money he had to spare, but still had a parole interest in Appleby's inventions. Parker & Stone were several thousands of dollars behind, and Appleby had passed through nearly a score of years of such scorn and disrepute as only the creator of future benefits for his fellow-creatures can ever know, and had not a dollar to show for his twenty years of incessant toil. Yet he had at that time perfected machinery which was soon to save millions of dollars yearly to the producers of wheat; and was literally, as said in the first lines of this story, to cheapen the price of every loaf of bread eaten in the world.

It requires five men to follow a reaper to bind the grain as it is cut. There are about 125,000 reapers made yearly in America; these reapers have each a life of fully seven years, hence there are 875,000 reapers in active use at once. To bind the grain cut by these reapers would require the labor of 4,375,000 skilled hand binders; this labor would cost, could it be obtained, at least $5,000,000 a day for each day of harvest time, all of which is saved by the use of Appleby's invention, or nearly all of it. Part of it, of course, is spent in the increased labor on reaping machines required to build the self-binding actions. But these skilled grain binders could not be had all at one time of the year, at any reasonable price, and nothing like the present harvests of wheat could be taken care of at the right time, if hand labor were the only agent for binding bundles of cut grain. Beside such enormous daily payments for labor as those mentioned above, how small appears even Deering's fortune of $20,000,000 accumulated in the manufacture of reapers, and how absurdly inadequate is the few hundred thousand dollars which represents Appleby's gains from his invention of the twine binder.

From 1876, the year of the first 115 automatic twine-binding reapers, the progress of Appleby's invention was rapid indeed. The faults of wire binding were becoming widely known, and the automatic binder was a recognized necessity. The twine binder's day had come.

The wire binder first came out in 1873, and continued in manufacture until 1880; in 1877 the wire binder was at the hight of its popularity, and seemed certain to remain in permanent use; yet it was wholly discarded only three years later so rapidly did the real merits of the Appleby twine binder gain public recognition. In 1878 Parker & Stone, well advanced in years, sold out; the new firm was known as Parker & Dennett, Parker being a son of C. H. Parker, and Dennett former general manager for Parker & Stone. The establishment was moved to Milwaukee, began operations under a license from Appleby, reached a considerable success, and finally sold out to the Milwaukee Harvester Company.

Appleby now had his patents, in which Bishop and Parker & Stone still held certain equitable interests, secured only by parole contracts with Appleby; to enhance the value of these interests, Appleby set to work to introduce the twine binder in new places, going first to the then young and thriving establishment of Gammon & Deering. In 1879 Appleby built 75 binders for Deering, he superintending and directing the construction, and going into the field with them. They worked well, and were all sold. Gammon & Deering built that year of 1879, 4,000 wire binders and 75 twine binders. In 1880 Gammon & Deering built 4,000 of the Appleby twine binders, and 3,000 wire binders; the wire binders would not sell, and were finally put into the scrap pile, and twine binders put in their places. In 1880 Appleby built a twine binder for George Esterly, of Whitewater, Wisconsin, making the same license as made to Gammon & Deering, and to the Milwaukee concern, and the twine binder began to bring a little money, only a few hundred dollars, to its inventor.



STEELE & CRAVER'S SHOPS.

In this same year of 1880 Appleby went to Minneapolis, Minn., and built a machine for the Minneapolis Harvester Company, and became their superintendent, building 80 machines in 1880 and 2,500 machines in 1881, and constantly increasing their output until they reached about 8,000 in one season, when they sold to Walter A. Wood. After licensing most of the larger manufacturers of reaping machines, Appleby finally sold all of the old patents to Whitely, Fassler & Kelly, of Springfield, Ohio, for $255,000, which was divided evenly with Dr. Bishop and Parker & Stone, $85,000 to each, thus amply recompensing those who had not too generously nor too steadfastly assisted the impoverished Appleby in the production and perfecting of his invention.

"It was along in 1883," said Mr. Appleby in answer to an inquiry as to Farmer Hatch who first led Appleby's mind to the problem of the self-binding reaper; "it was along in 1883 I saw Hatch one day on the street in Minneapolis; he was driving team; had been in the army, lost his farm, was poor and teaming for a living; I knew him the moment I saw him, and I spoke to him; he had forgotten me, but remembered me when I recalled the old days when I was Johnny Appleby, the boy on his farm. He asked me what I was doing, and I told him I was building binders for the Minneapolis Harvester Company. He was very much surprised, and said he knew the superintendent of the Harvester Works was named Appleby, but he had never thought of Johnny Appleby as being that superintendent. A little while afterward he applied to me for work, and I gave him a laborer's job in the Harvester Works, and a day or two after he came in I met him with a wheelbarrow load of castings. I stopped him and asked him if he remembered that day in the harvest field on his farm, when I told him I would show him some day I could build a binder, and that he called me a little fool and said I could not do it. He said he remembered it well enough, but had hoped I had forgotten it. I passed on without telling him how little likely it was that I should ever forget his words."

Mr. Appleby, who will as a matter of course die in the harness he has worn too long to leave, is now mechanical engineer for the Steele & Craver Company's fine works at Harvey, Ill. H. L. A.

Wants to be a Marine Engineer.

D. A. W., Johnston, R. I., writes as follows:

"I am a young man 24 years of age, unmarried, and a machinist by trade, and am desirous of becoming an A1 marine engineer. Now I have never worked in a shop where they build engines, so would you advise me to work a little while in some of the shops where they build engines? I hardly know what questions to ask, but I desire to become an expert marine engineer and am willing to work and study hard to become so if I could be advised the best way to do. I would have to work during the day, but could study nights or go to school at night. I have been out of my time two years, so I have some experience as a machinist."

This is a perfectly legitimate question to be addressed to us because we not only naturally feel disposed to be as helpful as possible in such cases but we also regard it as part of our business to be so. It is, however, a very difficult question to properly answer, because so much depends, because all depends, upon the individual. We do not even know that this young man wants to be what he says he wants to be. We do not know that he knows enough about the duties and the life of a marine engineer to be able to choose intelligently. We do not know that he has considered the chances of securing a life occupation in the chosen line after he has attained the necessary qualifications. If he does know what he wants to undertake he must know that he is proposing for himself a big job. "Would you advise me to work

a little while in some of the shops where they build engines?" It is rather discouraging that he should be able to ask such a question. Certainly go into a shop where they build marine engines, where they repair marine engines, where they talk and think and know about marine engines, where marine engineers hang around, so that you may find out what they know and how they learned it. This should be not for a little while but continuously, until you found yourself able to secure a more intimate relationship with the marine engine. Much must be learned in advance of the principles of operation, the details of construction and the routine of management. A portion of this must be learned from books and by hard study, and another portion can be learned only by practical experience. To become an expert engineer one must begin in the most subordinate position, and no matter what may be the natural and acquired qualifications, progress must be slow to the positions of full and supreme authority. In our issue of July 4th, this year, in answer to Question No. 269, we outlined a course for a marine engineer.

Hot Engine Room.

Mr. Borthwick, chief engineer of the U. S. monitor "Amphritite," 56 years old, with a sea-service record longer than that of any other chief engineer in the Navy, attempted suicide a few days ago. Mr. Borthwick had but one assistant, and when steaming they stood watch and watch. The vessel has twin-screw compound engines, six boilers, and the usual complication of pumps and auxiliary engines to be looked after, and the temperature of the engine room is 140 degrees.

"The number of hands whose wages have been raised is by one journal stated as high as 315,000, in 430 establishments, and by others at lower figures. It is really much larger."—*N. Y. Tribune.*

NEW CATALOGS.

The Kalamazoo Cycle Co., Kalamazoo, Mich., send us a catalog which is devoted especially to carriers of various kinds designed to be attached to any bicycle. It is 8¼x5½.

We have received from the Bickford Drill and Tool Co., Cincinnati, Ohio, a pamphlet containing numerous favorable expressions of opinion by users of the machinery built by this firm. It will be found interesting, and is standard size, 6x9.

We have received from the Mich'gan Mining School, Houghton, Mich., their "Prospectus of Elective Studies." A copy of this prospectus will be sent to those interested upon application, and will assist those who wish to make a selection of certain studies they may wish to pursue under favorable conditions.

The Sheffield Car Co., Three Rivers, Mich., send us a catalog of their small cars, designed particularly for being propelled by hand upon railways—either the regular standard roads or mining roads. The text of this catalog is published in English, French, German and Spanish, and it is designed especially for circulation in foreign countries. It is standard size, 6x9.

We have received from Kenney & Co., Scottdale, Pa., a large and fine catalog devoted to the illustration and description of machinery and tools especially adapted for use in mines. These include engines and boilers of various types, dumps, hoisting machinery, air compressors, coke and ore crushers, cars for conveying material, and, in fact about everything in the way of machinery or tools that is used in mining operations. The catalog is large standard size, 9x12.

MANUFACTURES

Jansen Bros., of Columbia, Pa., is to enlarge their rolling-mill plant shortly.

It is said that the New Castle (Pa.) Electric Light Co. will shortly enlarge their plant.

The Langley Mfg. Co., of Langley, S. C., has increased its capital, and will erect an additional mill.

The Crystal Springs Lumber Co., of Houston, Texas, has been formed, with a capital stock of $50,000.

The Argon Co., of Chicago, Ill., has been incorporated by John G. Campbell, with a capital stock of $500,000.

The Marlboro Mfg. Co., of Alice, S. C., has been incorporated by A. T. Manship, with a capital stock of $40,000.

The Riverside Cotton Mills have been organized at Island Ford, N. S., by J. H. Yount, with a capital stock of $50,000.

The Globe Machine Co., of Chicago, Ill., has been incorporated, with $75,000 capital, by Ed. M. Gage and Milton A. Sherman.

The Wheeler Mfg. Co., of Louisville, Ky., has been formed, with $25,000 capital, by W. Meade Robinson and others.

The Newton Machine Tool Works, of Philadelphia, advise us that they have advanced wages of employes 10 per cent.

The National Mantel and Tile Co., of Baltimore, Md., has been organized, with $50,000 capital stock, by John J. Kelly.

The Norton Can Co., of Anderson, Ind., has been incorporated by John M. Lutz and Albert M. Jones, with a capital of $100,000.

The Jaques Mfg. Co., of Kansas City, Mo., has been incorporated by Abbie L. and C. E. Jaques, with $100,000 capital stock.

The Colleton Cotton Mills, of Walterboro, S. C., has been organized, and will shortly erect a plant. A. C. Shaffer is interested.

It is said that a new cotton company will be organized at Roanoke Rapids, S. C., by W. S. Parker, with a capital of $200,000.

The Tinker Woolen Mfg. Co., of St. Joseph, Mo., has been incorporated by Joseph R. and Ernest L. Tinker, with a capital of $25,000.

The Enterprise Manufacturing Co., of Louisville, Mo., has been incorporated by E. B. Sippett and C. W. Tatton, with $10,000 capital.

The Kingman-Gilbraith Implement Co., of Peoria, Ill., has been incorporated by Martin Kingman and others, with a capital of $100,000.

The Electric Wire Hanging Insulator Co., of Chicago, Ill., has been formed, with a capital of $200,000. Edgar O. Baker is interested.

The Alabama Car and Equipment Co., of Montgomery, Ala., has been organized, with a capital stock of $100,000. J. J. Woodward is president.

The Patton's Adjustable Shelving Co., of St. Louis, Mo., has been incorporated by John D. Patton and L. D. Moore, with $50,000 capital stock.

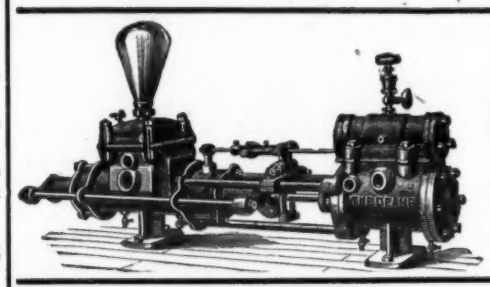
The San Antonio (Texas) Sewer Pipe Manufacturing Co. was recently organized, with a capital of $100,000. Aaron French, of Pittsburg, Pa., is president.

At Chicago, Ill., the Central Engine Power Co. has been incorporated by Herbert E. Gilbert and Joshua T. Gillelan, with a capital of $500,000, to manufacture engines.

The Ingersoll-Sergeant Drill Company are to add 200 feet to the main building of their factory at Easton, Pa., at once, and an equal addition at the other end is in contemplation.

J. E. Snyder, of Worcester, Mass., has removed his business from 17 Hermon street, that city, to 100 Beacon street, where, he informs us, he has three times the floor space formerly occupied, with much better light, and increased facilities for manufacturing his well-known drill presses.

Ward Bros., Cadiz, Ohio, have added to their establishment a department in which they will manufacture a woven wire fence. They have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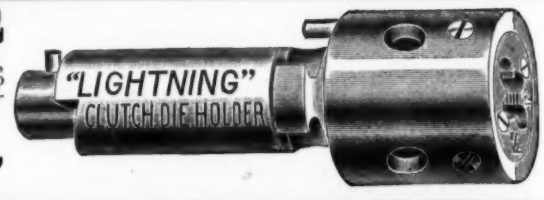

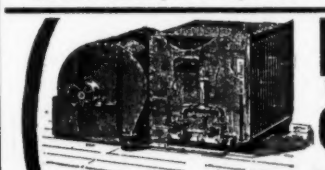
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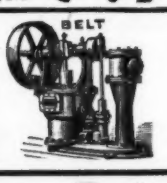

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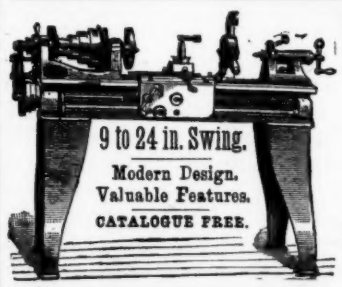

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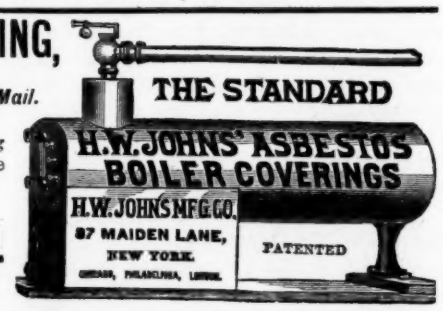
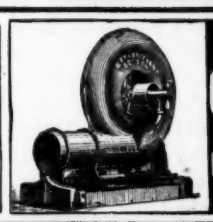
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.
87 Maiden Lane, NEW YORK.


Crescent Steel Co.
PITTSBURGH, PA.
CHICAGO, ILL.
NEW YORK, N. Y.
THE FINEST STEEL MADE.
Crescent Special
FOR DIES AND TOOLS DOING VERY HARD WORK.

FOR REDUCING WATER PRESSURE.
We manufacture a valve to reduce the pressure from the street water main to a low pressure for houses and buildings.
LARGE DISCOUNTS. WRITE FOR PRICES.
THE MASON REGULATOR CO., 6 and 8 Oliver St., Boston, Mass.

BUFFALO VENTILATING FANS
ELECTRIC, STEAM AND PULLEY TYPES. GREATEST AIR VOLUME, LEAST POWER
BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.
Chicago Office, 22 and 24 West Randolph Street.
PROGRESSIVE AND APARTMENT TYPES
BUFFALO LUMBER DRY KILNS.
BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

THE STURTEVANT PORTABLE FORGES
ALL SIZES & STYLES
SEND FOR CATALOGUES TO
B.F. STURTEVANT CO. BOSTON MASS.
NEW YORK PHILA. DELPHIA CHICAGO LONDON


THE STURTEVANT PRESSURE BLOWERS
ALL SIZES & STYLES
SEND FOR CATALOGUES
B.F. STURTEVANT CO.
BOSTON, MASS.
NEW YORK PHILA. CHICAGO LONDON

BORING AND TURNING MILLS
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
We have a variety of sizes and a large stock for immediate shipment.
THE BULLARD MACHINE TOOL CO.,
E. P. BULLARD, Pres't. BRIDGEPORT, CONN.
New York Office, 86 LIBERTY STREET.

erected a foundry for making castings used in the construction of this fence, and have put in two weaving machines, with the expectation of having six of these machines running by December next.

The Niles Tool Works Co., Hamilton, Ohio, have recently awarded contracts for what will be one of the largest, if not the largest, foundry in the United States. It will be 436 feet by 300 feet, with wings, and will be fully equipped with overhead traveling and jib cranes. There will be five cupolas, with a capacity for melting 125 tons of iron per hour.

The Lodge & Davis Machine Tool Co., of Cincinnati, Ohio, U. S. A., have just issued a large handsome poster printed in four languages—English, French, Spanish and German, illustrating their various lines of engine lathes, milling machines, planers, drill presses, shapers, screw machines, etc. This poster will be mailed to any address on application.

It is announced that the partnership existing between Mr. Wm. A. Russell, of Lawrence, Mass., and G. F. Evans, Newton, Mass., has been dissolved by mutual consent. These gentlemen have been doing business under the name of the Evans Friction Cone Co., and the business will be carried on in the future by Mr. G. F. Evans under the same name, and at the same address, 85 Water street, Boston, Mass.

The National Water-Tube Boiler Co., of New Brunswick, N. J., has been reorganized, and at the recent annual election, Mr. James Deshler, of the United States Rubber Co., was elected president; Warren A. Greene, of the Lambertville Rubber Co., vice president; John C. Evans, general manager Meyer Rubber Co., treasurer, and Joseph Fisher, of New Brunswick, secretary.

The Weir Plow Co., of Monmouth, Ill., inform us they have in contemplation the removal of their plant, and are considering proposals from a number of places, among them being East Moline, Ill., Belt City, Ill., Chicago Heights, Ill., Streator, Ill., Alton, Ill., and Springfield, Ill., and others. That we propose to build a large and modern plant for the manufacture of walking plows, wheel plows, shovel cultivators, disk cultivators, spike tooth harrows, disk harrows, cotton planters, corn planters and listers. Machinery and equipment will be very largely new.

We are informed that the business formerly carried on by Mr. Gustav Diechmann, at Berlin, Germany, will be continued by the new firm of Gustav Diechmann & Son. This firm is the German representative of several American machinery builders, including Brown & Sharpe Mfg. Co., F. E. Reed Co., The Niles Tool Works Co Mr. Diechmann was formerly chief engineer at Fried. Krupp's Cast Steel Works, and has been instrumental in introducing the Twedell system of hydraulic tools in Germany. The firm will also act as consulting mechanical engineers.

Machinists' Supplies and Iron.

NEW YORK, July 13, 1895.

Iron—American Pig—We quote standard Northern brands, $14 for No. 1; $13 for No. 2; $12.25 for No. 2 Plain, and $12 for Gray Forge. Southern brands, $13.50 to $14 for No. 1; $13 to $13.25 for No. 2; $12.50 to $12.75 for No. 3; $13 to $13.25 for No. 1 soft; $12.75 to $13 for No. 2 soft; and Foundry No. 4, $12.25 to $12.50

Antimony—A fair jobbing business has been done, and prices remain steady. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¼c. to 8½c; Hallett's, 7½c. to 7.15c; U. S. French Star, 7.35c.; Japanese, 7c. to 7⅛c.

Lard Oil—Prime City we quote at 51c. to 52c.

Copper—The market is firm with higher prices. The demand by consumers is lively, and a good business has been done. Lake Copper has been sold at 10⅝c. to 10¾c., and it is said that 11c has been reached. Buyers are freely offering 10.70c. to 10.75c. for early deliveries, and 10.75c. to 10.80c. for futures. Casting Copper is held at 10¼c. to 10½c.; the demand is moderately active.

Lead—Business remains good with an increase in price. Sales have been made at 3.32½c., but 3.35c. is the ruling figure for New York delivery.

Spelter—The market is somewhat irregular, but the demand has been good. For New York delivery 3.70c. to 3.75c. is asked.

Tin—The market is active, and the demand by consumers is good. For prompt and future deliveries 14.25c. is asked.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS.

On and after July 4th this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Bright, active machinists to canvass for subscription to AMERICAN MACHINIST, liberal commission. Address, with refs., Subscription Dep't, AMERICAN MACHINIST, 203 Broadway, N. Y.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Mechanical draftsman, 11 years practical exp., wants pos. A1 refs. F. A. M., AMERICAN MACHINIST.

Wanted—Machinist wants position; have had experience in machine shop, also technical education. Address Box 47, AMERICAN MACHINIST.

Wanted—A good patternmaker to work on waterwheel patterns. Apply or correspond with William Dolan & Co., Logansport, Indiana.

Mechanical draftsman with technical education, experienced in hoisting and general machinery, wants position. Box 44, AM. MACHINIST.

Wanted—A few first-class tool makers and die sinkers. Apply, stating price and experience, Remington Arms Company, Ilion, N. Y.

Wanted—A working foreman to take charge of molding room, work on engines and general machinery; competent man only. Box 54, AM. MACH.

Foundry foreman wants situation, 15 yrs. exp. as foreman in an engine and jobbing shop; first class references. Address Wells, AMERICAN MACHINIST.

Wanted—Position as tool maker, under instructions, by young man; served apprenticeship in first-class machine shop and has had some experience in tool room. Box 49, AMERICAN MACHINIST.

Wanted—Machinist familiar with rapid production of small interchangeable work. Only skilled men need apply. State experience, class of work, age, and salary expected. Apply Box 52, AM. MACH.

Position wanted by a B. M. E., a graduate of the best technical school; drafting or steam engineering preferred; good references. C. G., care AMERICAN MACHINIST.

First-class mech. engineer and draftsman, exp'd in marine and stationary steam engineering, gen. mach. and structural work, wants pos. Box 53, AM. MACHINIST.

Wanted—Position as foundry foreman, engine work preferred, a practical melter, and understands how to get the work out cheap. References. Address Cheap Castings, AMERICAN MACHINIST.

Brass worker, general experience in finishing, founding, and all the metals now in use, wants a steady position at moderate salary; refs. Address G. W., 210 N. Sixteenth street, St. Louis, Mo.

All-round machinist, in present position 6 years as general foreman, a hustler, sober and reliable, wants position; west of Chicago preferred. Address Box 46, care AMERICAN MACHINIST.

Wanted—Position as foreman or to lay out in boiler or gas holder works; 10 years' experience as foreman; A1 references. Address Box 31, AMERICAN MACHINIST.

Wanted—A competent manager for boiler works and machine shop; must be experienced and able to give estimates if required. Address F. C., 59 Liberty St., Room 16, N. Y. City.

Wanted—Position by millwright draftsman; technical graduate with three years' experience as constructing engineer on pulp mills; best of references furnished Address Mill, AM. MACHINIST.

Mechanical engineer wants position in machine shop, or chief engineer of steam plant—electric or other; 30 years' experience; best references. Address 1171 Constance street, New Orleans, La.

Wanted—Position as foreman or superintendent by practical man of 22 years' experience in manufacture of brass goods, plumbers' and steam fitters' supplies; best of refs. M., AMERICAN MACHINIST.

Wanted—Draftsman who is familiar with printing presses, must be active, reliable, understand his business, and be able to instruct others; to insure consideration, state age, experience, and salary expected. Box 50, AMERICAN MACHINIST.

(*Continued on Page 574.*)

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of

Iron and Steel Bridges and Buildings.

The above illustration, taken direct from a photograph, shows the interior of an Iron Foundry designed and built by us for The Farrel Foundry and Machine Co., at Ansonia, Conn. The building is 129 feet in width by 302 feet in length. The wings are 30 feet and 43 feet respectively, and the central portion is 56 feet in width. The central portion of the building is controlled by a hydraulic traveling crane, with a travel the full length of the building, and is also arranged with jib cranes for delivering material from the traveling crane to the cranes in the wing trusses.

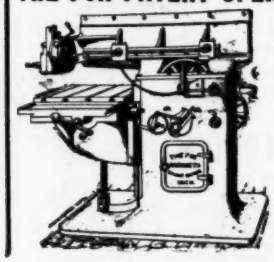
SEND FOR OUR ILLUSTRATED CATALOGUE.

ROOTS' NEW ACME HAND BLOWER.
For Blacksmiths, etc. Slow Speed, Positive Blast. Is Durable Compact and Cheap; also Portable Forges, Tuyere Irons and Foundry Blowers.

P. H. & F. M. ROOTS, Mfrs.
CONNERSVILLE, IND.
Chicago Office: 1405-10 MANHATTAN BUILDING.
COOKE & CO., Selling Agents,
163 & 165 Washington St., NEW YORK.
Please Mention This Paper.

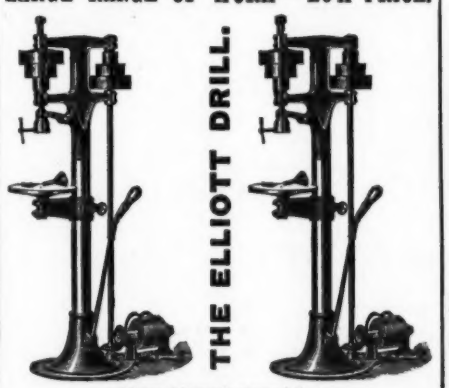
HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
☞ Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

THE FOX PATENT OPEN SIDE SHAPER.



No springing of ram. No overhanging table. Quick Return, Stroke Under Perfect Control. Can be Instantly Adjusted 1-16 in. or 24 in. No Screws to Monkey with. Powerful, Quick, Accurate. Write for circular.
The Fox Machine Co.,
325 N. Front St.,
Grand Rapids, Mich.
135 Finsbury Pavement, London, England

The Elliott Drill Press
FOR ANY LIGHT WORK.
LARGE RANGE OF WORK—LOW PRICE.



THE ELLIOTT DRILL.

Now Manufactured by
A. J. WILKINSON & CO.,
180 to 188 WASHINGTON ST., BOSTON, MASS.
SEND FOR CATALOGUE.

C. W. LE COUNT,
SOUTH NORWALK, CONN.
REDUCED PRICE OF LE COUNT'S HEAVY STEEL DOG

No.	Inch.	Price.
1	⅜	$ .48
2	½	.60
3	⅝	.80
4	¾	.96
5	⅞	1.20
6	1	1.50
7	1 1-8	1.80
8	1 1-4	2.10
9	1 3-8	2.40
10	1 1-2	2.85
11	1 5-8	3.10
12	1 3-4	3.35
13	1 7-8	3.60
14	2 1-2	4.45
15	3	4.60
16	3 1-2	4.80
17	4	5.10
18	4 1-2	5.75
19	5	6.25
Full set of 19		$21.60
20 (ext.)	5 1-2	4.00
21 (ext.)	6	5.00

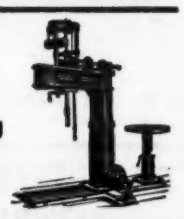
This Dog has a Very Heavy Boss, so that if the thread wears a Heavier Screw can be substituted.

Le Count's Heavy Steel Dog.
With Steel Screws, Lathe Made and Hardened.
When ordering, state as above, whether a full set or a set of 12, or small set of 8. Users of these dogs prefer them to any other make.

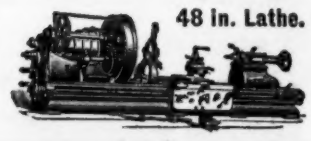
One Small Set of 8—by 1-4 inches to 20 inch, . . $6.25
One Set of 12—by 1-4 in. to 2 in. continued by 1-2 in. to 4 in. 13.25
These goods are for sale by CHAS. CHURCHILL & CO., L'td, 21 Cross St., London, England.

ALUMINIUM
MODEL ENGINE CASTINGS
DESCRIPTIVE PRICE LIST FREE
CHAS. W. STEVENER.
TARENTUM PA.

BETTS MACHINE COMPANY,
MACHINE TOOL BUILDERS,
WILMINGTON, DEL.



LATHES
AND OTHER METAL-WORKING TOOLS.
Catalog E.
FITCHBURG MACHINE WORKS,
FITCHBURG, MASS.



48 in. Lathe.

JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

We claim for
Bohler Bros. Styrian Tool Steels
The greatest strength, uniformity and longest endurance. It is unequalled for Milling Cutters.
HOUGHTON & RICHARDS, SOLE AMERICAN AGENTS.
148 & 150 Oliver St., BOSTON.

WORTHINGTON CONDENSER.
ONLY APPARATUS that can MAINTAIN a VACUUM on ENGINES and ELEVATE the discharge WATER to TANK at any height.
This feature is appreciated by PAPER MILLS, SUGAR REFINERIES, COTTON and WOOLEN MILLS.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St. BOSTON, 70 Kilby St. PHILADELPHIA, 607 Arch St. CLEVELAND, 24 South Water St. CHICAGO, 185 to 189 Van Buren St. ST. LOUIS, Eighth and St. Charles Sts. INDIANAPOLIS, 64 South Pennsylvania St.

An experienced foreman patternmaker of ability, used to handling men, and is not slow, desires position, is a good draftsman and accustomed to machinery. Address F. P. M., American Machinist.

First-class engineer and machinist, good draftsman and expert with indicator, desires to take charge of power plant and repairs of manufacturing company, or superintendent of machine shop; well up in best modern practice. A. B., American Machinist.

Wanted—A position as foreman or assistant to superintendent of machine shop by a good all around machinist, am fair draftsman, and can make a good shop sketch; at present in charge; age 32; west of Ohio preferred. Address Box 45, American Machinist.

An engineer of considerable experience, familiar with the most modern marine engineering construction, both in drawing, office and shop practice, wishes a situation as superintendent, engineer or other position of responsibility. For testimonials apply to office of this paper. Box 55, Am. Mach.

Wanted—Foundry foreman, not over 45 years old; fully acquainted with best modern methods; accustomed to green, dry sand and loam; must be able to handle about 100 men and produce castings at low cost, work being heavy machinery, steam engine and general castings; state age, experience and salary expected; give references. Address Blank Foundry, care of American Machinist.

A young mechanical engineer and designer of 11 years' practical experience, well-educated and apprenticed at machinist's trade in leading steam engine and mach. tool works; later experience in heavy steam engine design, high-speed engines hoisting and mining machinery, and machine shop and foundry special tools and equipment, desires to negotiate for a change in the near future. Box 56, American Machinist.

Wanted—Assistant foundry foreman in a New England city; must be accustomed to light and heavy machinery and steam engine work, acquainted with the latest and best foundry methods, and have first-class executive ability and push; state nationality, age, and give full account of experience; give references and state salary expected. Address New England Foundry, care American Machinist.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 25 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York,Clev'd,O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H Baush & Sons, Holyoke, Mass.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

Wanted—A powerful 1½" or 2" open die bolt cutter (dies to revolve); state cash price. Wm. Menge, Dolgeville, N. Y.

Wanted—Second-hand lathes, planers, shapers, drills, screw machines, milling machines, and boiler tools, etc. Address Box 51, Am. Machinist.

For Sale—Old-established machine shop in Camden, N. J., with good trade—"very cheap." Geo. W. Jessup, 411 Market street, Camden, N. J.

Wanted—To correspond with any one in need of a first-class key-seater, Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

Wanted—An Idea. Who can think of some simple thing to patent? Protect your ideas; they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offer.

Wanted—60-inch lathe, screw cutting, to take in about 6 feet between centers, in good order; give name of maker and full particulars; lowest cash price. Address Henry Vogt, 335 E. Main St., Louisville, Ky.

Wanted—Having a new, important and successful improvement in the Corliss or any type steam engine, am seeking men with capital and honesty, to take an interest, for which I will make liberal terms. Address H. F., care of American Machinist.

A good location for a man that understands blacksmith and machine work; tools and stock complete, to go to work. Will sell or trade. A better opportunity for a money maker cannot be found. Show this to your machinist and blacksmith friends. Write to Martin Hamm, Strasburg, Shelby Co., Ill.

CLEVELAND

ESTABLISHED IN 1874.

CLEVELAND TWIST DRILL CO.

99 Reade Street, New York.
85 Queen Victoria Street, London, Eng.
5 Neue Promenade, Berlin, C., Germany.
Cor. Lake and Kirtland Streets, Cleveland, O.

NEW AND SECOND-HAND MACHINERY.

ENGINE LATHES.

13 in. x 6 ft Blaisdell.
14 " x 6 " Flather.
15 " x 6 " Standard.
15 " x 8 " Standard.
16 " x 6 " Blaisdell.
16 " x 7 " Pratt & Whitney.
18 " x 8 " Fitchburg.
20 " x 8 " Putnam.
20 " x 10 " Harrington.
24 " x 12 " New Haven.
24 " x 10 " Standard.
24 " x 22 " Perkins
28 " x 16 " Fay & Scott.
30 " x 26 " with Shaft'g atts.
32 " x 16 " Waterman.
72 " x 20 " Union.

DRILLS.

Sensitive Drills, Improved.
28 in. Back Geared, Blaisdell.
Radials, 3, 4 and 5 ft. Arms.
Radial, 3 ft. Arm, Baush.

HOR. BORING & DRILLING MACHINES.

Sellers, 54 in. swing, complete.
Bement, 54 in. swing, No. 2.
Cyl. Borer 12 to 36 in. cyls.

PLANERS.

22 in. x 5 ft. Putnam.
22 " x 5 " Pease.
24 " x 5 " New Haven.
24 " x 6 " Lathe & Morse.
24 " x 6 " Rochester.
28 " x 5 " Gage.
30 " x 10 " Harrington.
48 " x10 " Gray, 2 Heads, A1.

SHAPERS.

8in. Stroke, Crank Motion.
15 " " " "Gould & E.
16 " " " "Prentiss.
14 " " Trav. Head, with centers, circular feed, Fitchb'g.

SLOTTERS.

10 in. Stroke, Lowell.
18 " " Bement.

BOILER ROLLS.

7½, 8 and 10 ft. Good order.
8 and 10 ft. New Improved.

SCREW MACHINES.

P. & W. No. 2 Wire Feed.
Brown & Sharpe No. 5, complete.

MILLING MACHINES.

Garvin No. 3 Power Feed.
Lincoln Pattern with Vise.
"Universal" Latest, good as new.
Ingersoll Heavy, 12 in. x 3 ft.

Gray Planers "NEW," 22, 24, 30 and 36 in.
Kempsmith Millers, Universal and Plain.
Bardons & Oliver's Screw Machines, Improved Style.
Fitchburg Lathes, 14 to 72 in. Swing.

J. J. McCABE,
SUCCESSOR TO
E. P. BULLARD'S
N. Y. Mach'y Warerooms.
14 Dey St.,
NEW YORK.

SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.

12 in. x 5 ft. Ballou Patent.
16 in. x 6 ft Ames Mfg. Co.
16 in x 8 ft. Perkins Taper.
18 in. x 10 ft. Blaisdell.
28 in. x 20 ft. Perkins.
37 in. x 14 ft. Maker Unknown.

PLANERS.

12 in. x 30 in. Wilkinson for Hand or Power.
22 in. x 22 in. x 4 ft. L. W. Pond.
24 in. x 24 in. x 5 ft. Putnam.
24 in. x 24 in. x 6 ft. Chamberlin.
24 in. x 24 in. x 5 ft. Whitcomb.

SHAPERS.

10 in. Pratt & Whitney.
12 in. Juengst, Crank.
15 in. Juengst Friction.
10 in. Wood and Light Traverse Head.
21 in. Smith & Silk, Shifting Belt.
20 in. Gould & Eberhardt.
24 in. Hendey, Friction.

DRILL PRESSES.

3 Spindle Woodward & Rogers.
6 Spindle Quint, Turret.

DRILL PRESSES.

No. 1 Two Spindle, Garvin.
No. 2 Three Spindle, Garvin.
No. 2 Four Spindle, Pratt & W.
No. 4 Four Spindle, Garvin.
20 in. Davis, Wheel Feed
24 in. Blaisdell Wheel Feed.
24 in. Aurora, Back Geared.
30 in. Pond, Back Geared, Power Feed.
9 ft. Holly Mfg. Co., Radial.

SCREW MACHINES.

No. 00 Garvin, Wire Feed.
No. 5 Brown & Sharpe.
2 No. 1 Brown & Sharpe, Wire Feed.
No. 2 Brown & Sharpe, Automatic.
No. 2½ Pratt & Whitney.
No. 2 Garvin, Plain.

MILLING MACHINES.

6 No. 2 Pratt & Whitney, Lincoln.
1 No. 20 Garvin, with arm.
2 No. 2 Garvin, Plain.
1 No. 0 Garvin Universal.
1 No. 1 Garvin Universal.
No. 2 Garvin Duplex.

Also, a large list of other machines. Write for complete list, detailed description and prices.

THE GARVIN MACHINE CO.,
LAIGHT & CANAL STS., NEW YORK.
Also, 51 North 7th St., Philadelphia, Pa.

MACHINE TOOLS.
IN FIRST-CLASS CONDITION.

16 in. F. B. Miles Slotting Machine.
2,400 Pound Miles Steam Hammer, Single Standard
30 in. by 27 ft. Pratt & Whitney Engine Lathe.
Horizontal or Floor Boring Machine, Pratt & Whitney.
Two (2) 5 ft. Universal Radial Drills.
21 in. x 11 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
19 in. x 8 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
26 in. x 8 ft. Pond Machine Tool Co. Engine Lathe.
19 in. x 12 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
22 in. x 12 ft. Pratt & Whitney Engine Lathe, Hollow Spindle
21 in. x 11 ft. Lodge & Davis Engine Lathe, Hollow Spindle and Taper Attachment.
40 in. Bement Vertical Drilling Machine.
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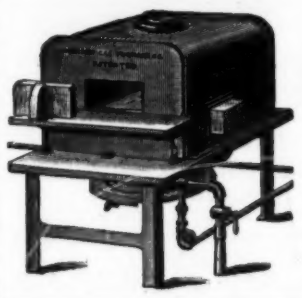

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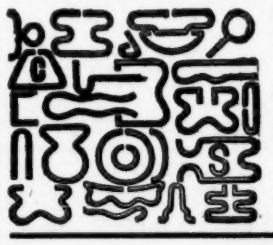

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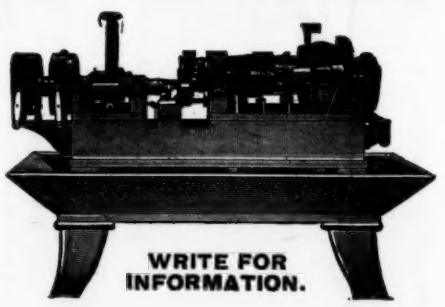

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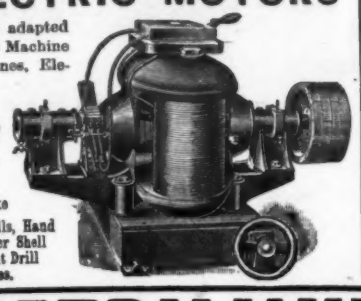

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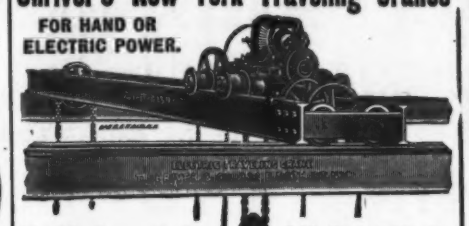

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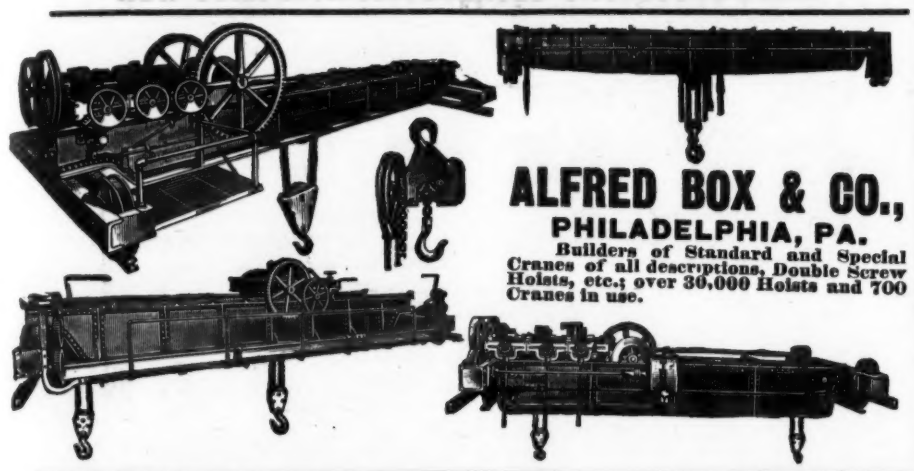

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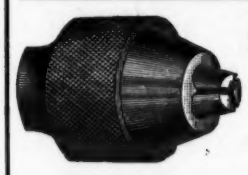

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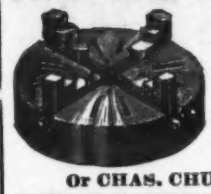

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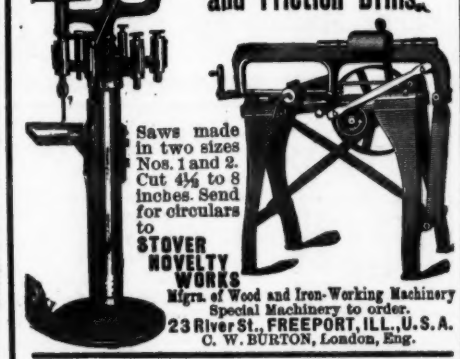

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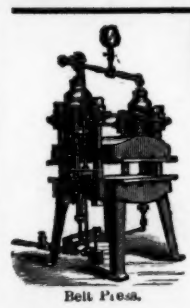

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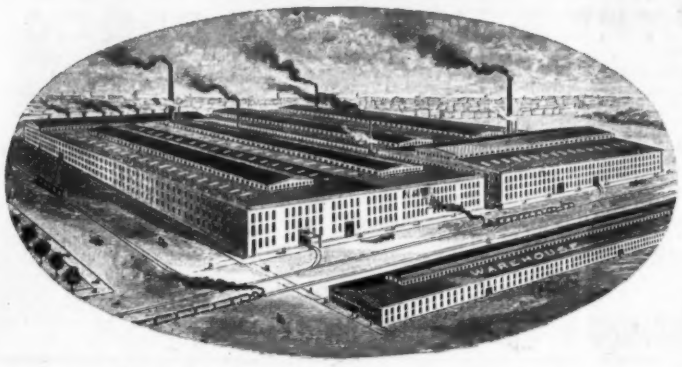

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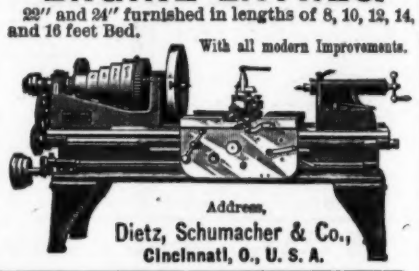

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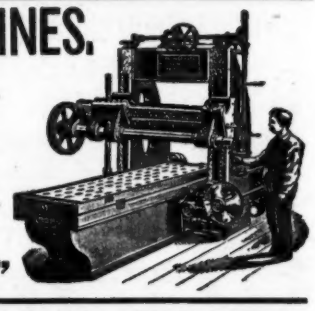

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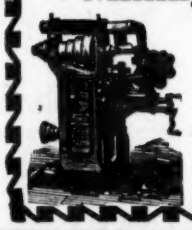

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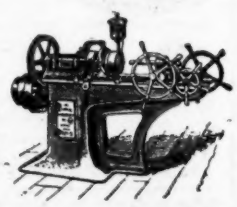

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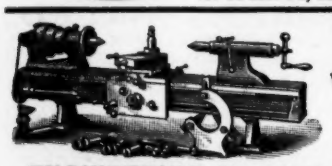

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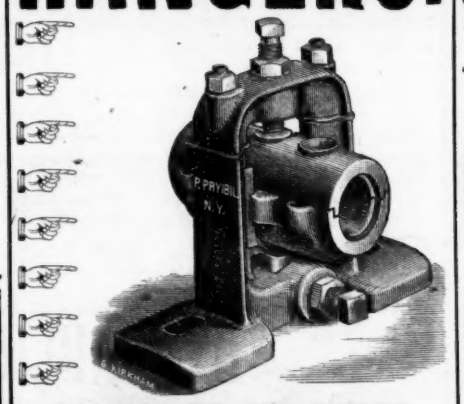

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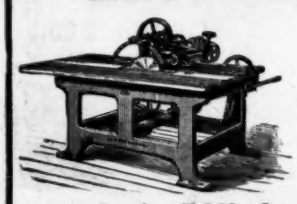

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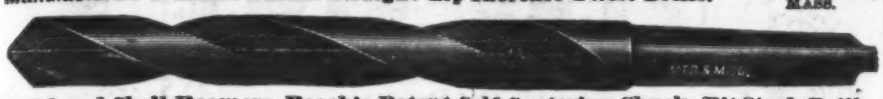

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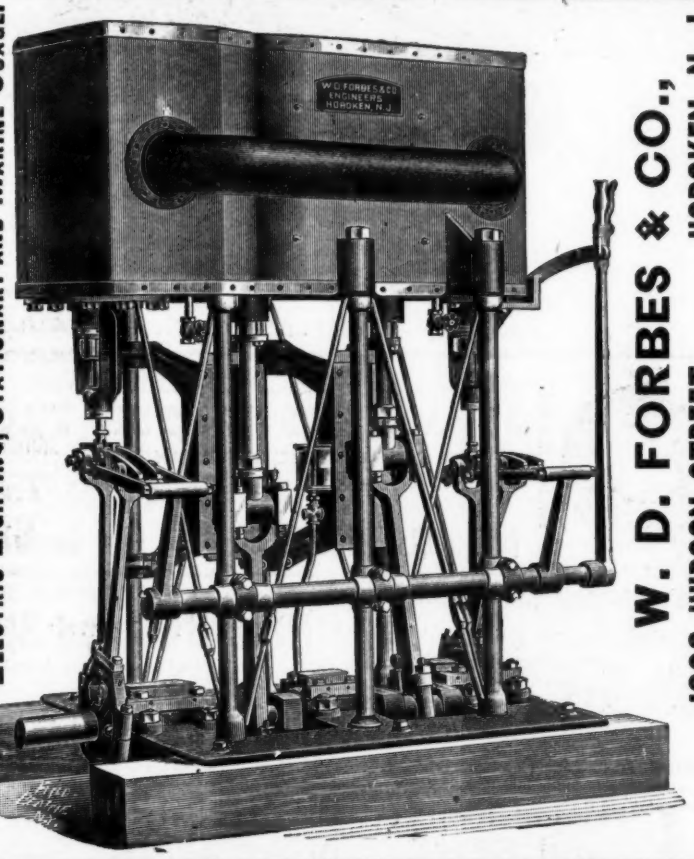

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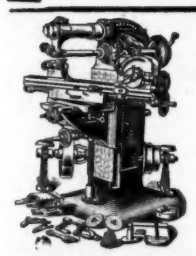

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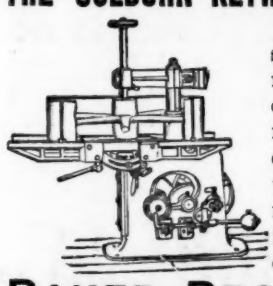

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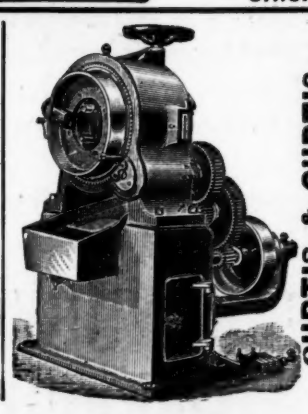

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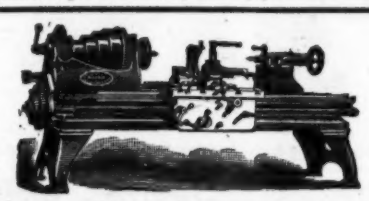

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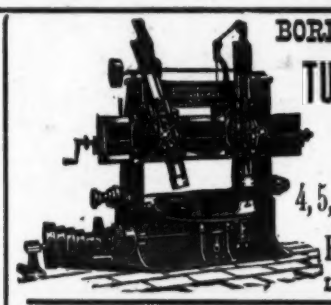

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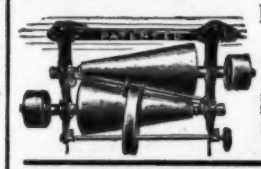

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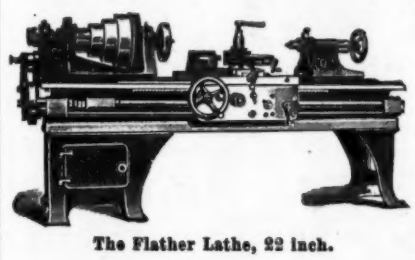

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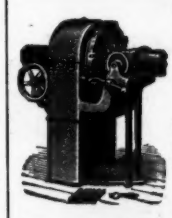

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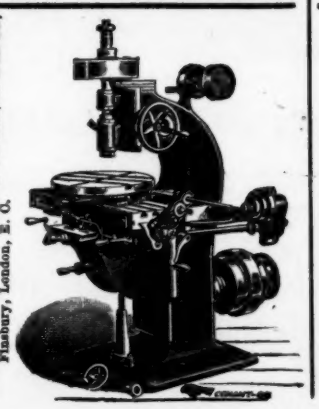

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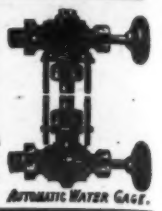

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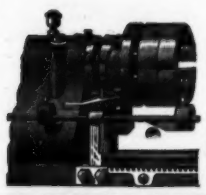

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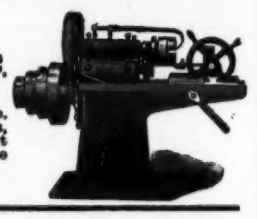

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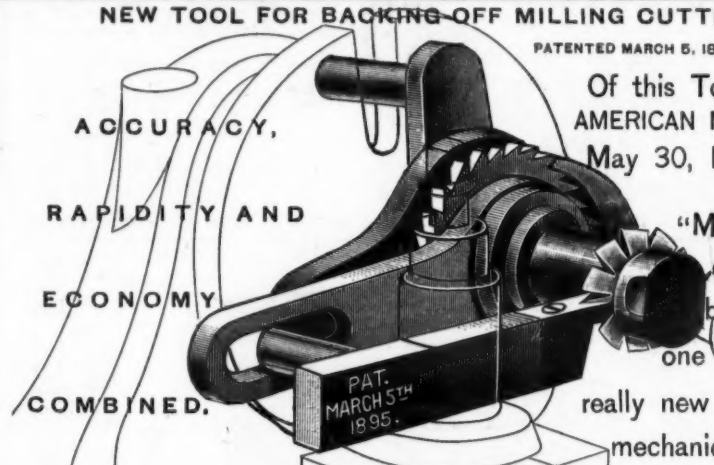

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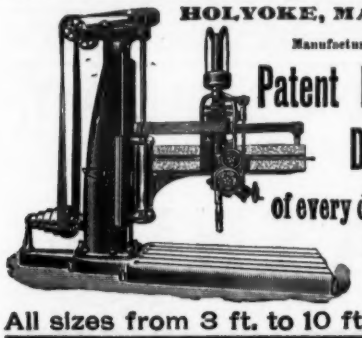

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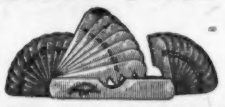

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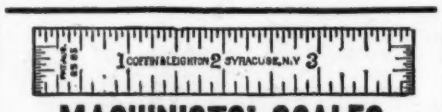

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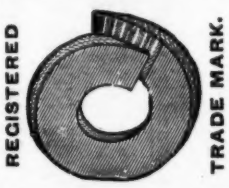

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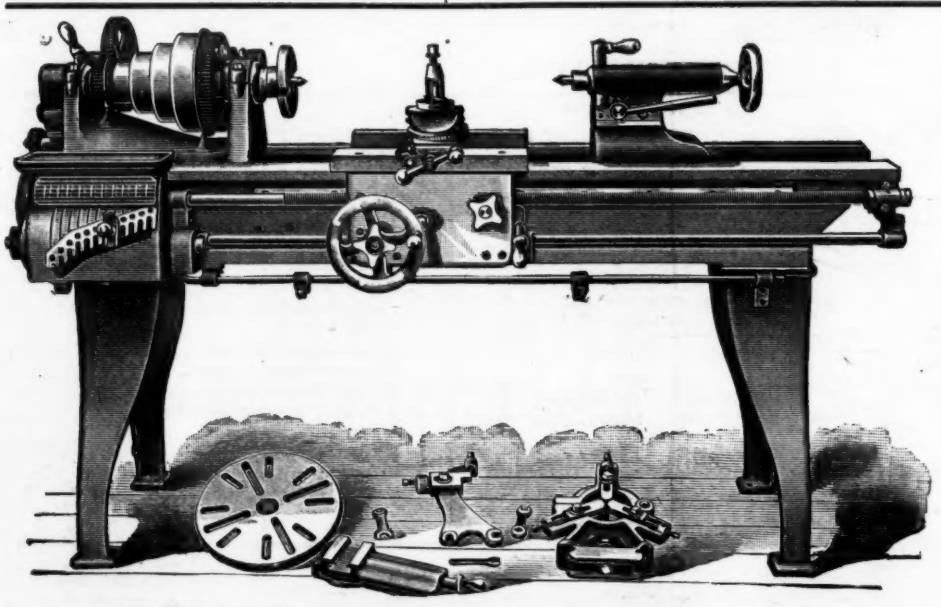

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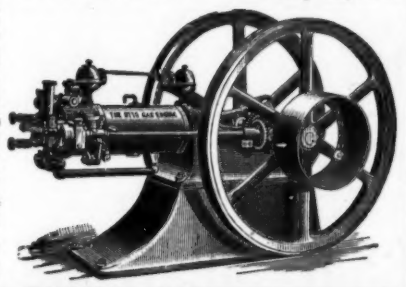

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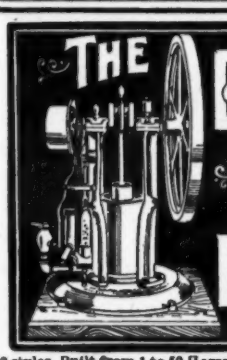

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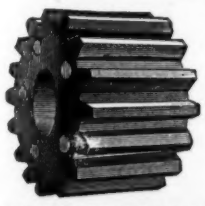

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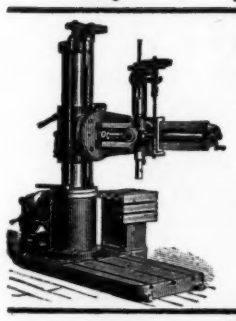

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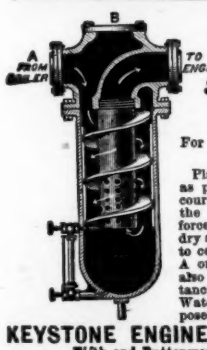

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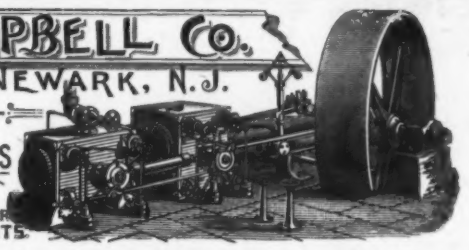

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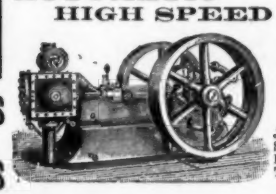

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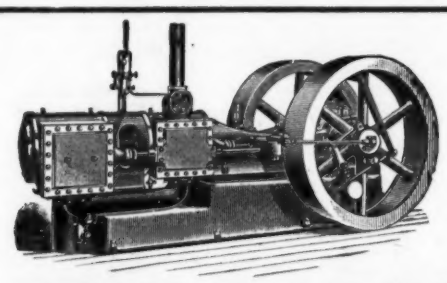

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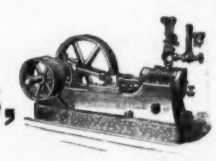

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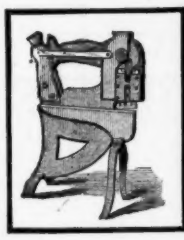

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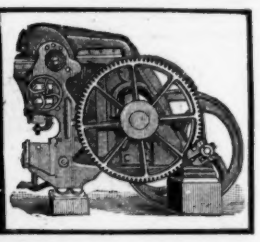

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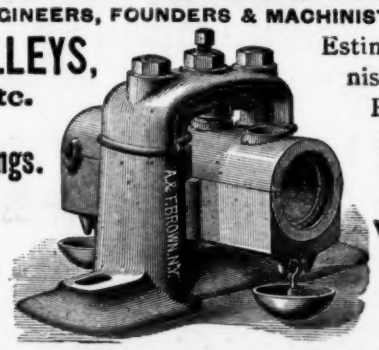

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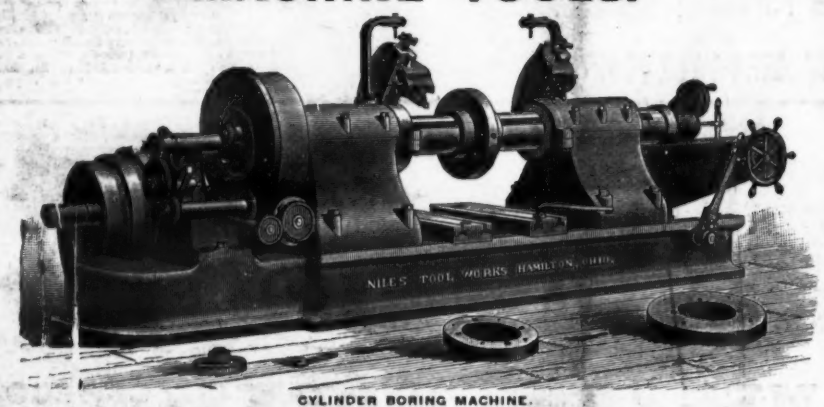

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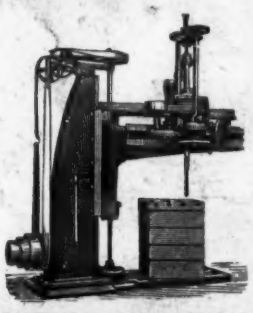

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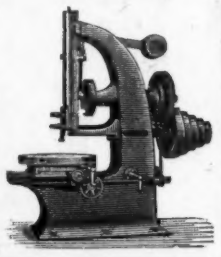

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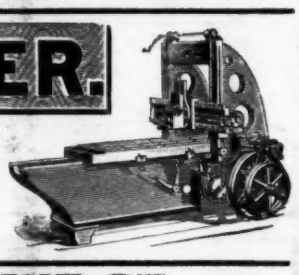

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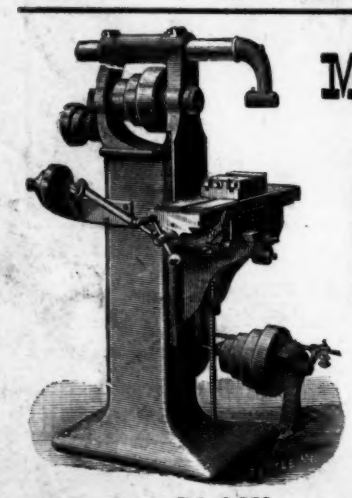

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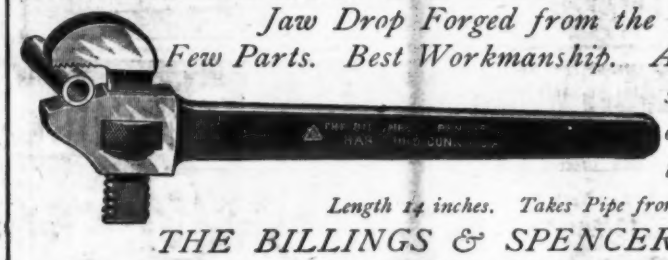

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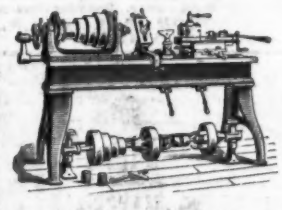

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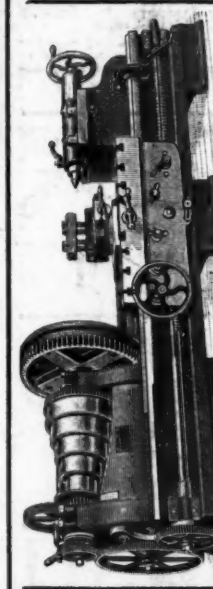

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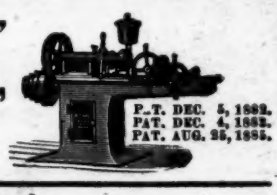

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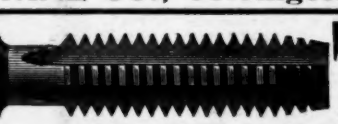

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